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THE WORK OF THE NAVAL OBSERVATORY.

By REAR-ADMIRAL C. M. CHESTER, U. S. N.

The Naval Observatory has apparently many fathers, but probably to no one belongs so much of the credit for its foundation as to Captain James Melville Gilliss, U. S. Navy.

A few men, among them notably Mr. William Lambert, of Virginia, were, as early as 1810, interested in the establishment of a first meridian for the United States, the location of which would seem to require an observatory of some sort, and fostered by the great talents of John Quincy Adams, they made strenuous efforts to have Congress take up the matter. President Adams' scheme was made with a broad foundation, however, for it was his wish to establish a National University, of which the observatory was to be a part. He based his views on the ground that "among the first, perhaps the very first, instruments for the improvement of the condition of men is knowledge; and to the acquisition of much of the knowledge adapted to the wants, the comforts, and the enjoyments of human life, public institutions and seminaries of learning are essential." But in spite of this declaration in his first message to Congress December 6, 1825, and in spite of the persistent work of himself and others in the matter, Congress

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turned a deaf ear to their demands and refused to give the money for the establishment of a university. Even did he fail when in a speech in Congress in 1842 in support of an appropriation for an astronomical observatory he appealed to their patriotism, saying: "It is with no feeling of pride as an American that the remark may be made that, on the comparatively small territorial surface of Europe, there are existing more than one hundred and thirty of these light-houses of the skies; while throughout the whole American hemisphere there is not one." But Mr. Adams himself, in a report (No. 581, 27th Congress, 2d session), expressed "his uncertainty whether Congress possesses under the Constitution the power to establish a National University," and it was this doubt that the opposition party worked upon to carry their dissent to the proposition.

December 6, 1830, the navy commissioners had, however, under the authority of the Department, established a bureau for the care of naval instruments and charts, and December 5, 1835, Hon. M. Dickenson, Secretary of the Navy, referring to it stated "It is necessary now to employ an officer of science to keep our maps and charts, &c., &c., and these duties would properly devolve upon the superintendent of an observatory" such as he recommended should be inaugurated. No results ever came from this discussion until Gilliss brought forth a scheme for a Naval Observatory which promised a quid pro quo to the nation itself, when Congress gave it favorable consideration and passed an act approved August 31, 1842, which authorized the Secretary of the Navy "to contract for a suitable building for a depot for charts and instruments for the navy." It should be remembered that this action was procured not merely through the persistent efforts he made to have Congress take up the matter, but in recognition of the work Gilliss had already done in an observatory, built without expense to the government at the "depot of charts and instruments" on Capitol Hill in the city of Washington.

One Senator (Preston of South Carolina), at a time when Gilliss made what was intended to be a last visit to the chairman of the naval committee, said to him, "Did you not give notice to the National Institute last night that you had found Encke's comet?" "Yes." "Then, I will help you all I can," and as he had been one of the strongest opponents of the scheme, within a week a bill authorizing its construction was passed by the Senate. "Taking

the report of the naval committee, which accompanied the bill as the exponent of the will of Congress," the Secretary of the Navy directed Lieutenant Gilliss to visit the northern cities for the purpose of obtaining information respecting plans for the construction of an observatory, and later he was sent to Europe for the same object. This was the beginning of the present Naval Observatory.

While systematic astronomical observations did not begin until 1838, when the Wilkes expedition started for the South Seas, the small observatory referred to above had been erected by that officer, who was then in charge of the "depot of charts and instruments," soon after its transfer to a new site on Capitol Hill in 1833. It was in this observatory that Gilliss began his astronomical career in 1836. Wilkes' predecessor, Lieutenant Goldsborough of the Navy, was the first officer ordered to the depot in 1830, and might justly lay claim to the authorship of an observatory even at an earlier date, for "in a small circular building, on a brick pier with a foundation 20 feet below the surface, he mounted a 3-inch transit instrument, made by R. Patten of New York City." To be sure the principal work done by the transit was for the purpose of rating chronometers, but there is no doubt that other astronomical observations were carried on at the same time. Wilkes' Observatory, built after the change in location of the "depot of charts and instruments" took place, contained a transit instrument of 3¼ inches aperture and 63 inches focal length, made by Troughton under Hassler's direction for the U. S. Coast Survey in 1815; loaned for the purpose and mounted on massive piers; a Borda's circle; a 3½ foot achromatic portable telescope; a portable transit instrument, and a sidereal clock.

In the summer of 1838, when the Wilkes expedition was about to leave the country, the Secretary of the Navy directed the superintendent of the depot of charts and instruments that during the absence of the expedition he should make a constant series of observations in astronomy, magnetism, and meteorology. He ordered an additional number of assistants, and granted authority for the purchase of all necessary instruments. Gilliss was the chief of the party to whom these instructions were given, and under the authority of the Naval Department he purchased additional instruments as follows:

A sidereal clock and a mean time clock; a meridian circle of

4.5 inches aperture furnished with circles 30 inches in diameter; a portable achromatic telescope of 3¼ inches aperture and 42 inches focal length.

Notwithstanding, therefore, that Congress did not authorize the establishment of an observatory until March 3, 1842, the Naval Observatory was really in practical operation several years earlier.

The late Dr. B. A. Gould, the recognized leader in astronomy of his day, wrote: "This was the first working observatory in the United States; and the volume containing the observations during the five years 1838-42, with the reduced results, was the first American volume of astronomical observations."

While this statement as to results is true it is hardly conceivable that Wilkes, who had formulated the instructions issued by the Navy Department in 1838 for the astronomical work to be carried on by Gilliss at Washington in conjunction with that of his own expedition in the South Seas, should have built an observatory as above described, in 1833, and not have done some astronomical work with it.

Dr. Gould says also of this work: "It was Gilliss who first in all the land conducted a working observatory, he who first gave his whole time to practical astronomical work, he who first published a volume of observations, first prepared a catalogue of stars, and planned and carried into effect the construction of a working observatory as contrasted with one intended chiefly for the purposes of instruction." This was what Congress demanded: a practical working observatory.

As showing the character of Gilliss' observations, I further quote from Dr. Gould the testimony of the eminent astronomer Walker on the subject. Gould says: "At a meeting of the American Association for the Advancement of Science, he (Walker) publicly stated, that after an extensive series of analogous examinations, made for the purpose of deciding the relative weight to be assigned to the results of different observers, he had found transit observations of only one astronomer, Argelander, which manifested equal precision with those of Gilliss."

Gilliss entered the Navy March 1, 1827, and was promoted to Passed Midshipman on June 10, 1833. Long years afterwards, he wrote in a letter to his friend Dr. Gerling as follows:

"Very shortly after I came to Washington for duty as a Passed Midshipman, members of Congress were told in my pres-

ence 'There is not an officer of the navy capable of conducting a scientific enterprise.' The charge was intended prejudicially to the service to which I belonged, and was the more humiliating because the speakers were unknown and defense was not possible. But from that hour no effort has been spared by which the standard of intelligence in the service might be increased and its reputation enhanced."

Gilliss' strong influence was lent also to the betterment of the education of officers in general, and this in association with other official influence eventually resulted in the establishment of the U. S. Naval Academy in 1845.

Soon after the disparaging remark spoken of by Gilliss in his letter to Dr. Gerling, he (Gilliss) applied for leave and entered the University of Virginia, " resolved," as Dr. Gould says, " so far as lay in his power to bring to his country's service the highest scientific culture attainable," and again in 1833 he took a six months' course of studies in Paris. With this determination clearly marked in his mind, it is more than likely that he did some astronomical work before 1838, as he had taken charge of Wilkes' observatory in 1836, and yet his records only began in 1838. At any rate, to have produced such results, he must have studied well before actual observations were commenced.

Gilliss applied himself to the task of formulating the plan for the observatory with a diligence and resourcefulness that had already marked him in scientific research, but as the astronomical resources of the country were at that time practically *nil*, his main study was concentrated on European establishments and particularly on that at Greenwich. The Greenwich Observatory had a constitution similar to that which was required of the new observatory, which was stated in the instructions contained in the warrant of each Astronomer Royal, as follows:

" To apply himself with the most exact care and diligence to the rectifying the motions of the heavens and the places of the fixed stars, in order to find out the much desired longitude at sea, for the perfecting the art of navigation."

The private observatories of Europe, and later on of our own country, were founded for research only, while the Naval Observatory was for practical work pure and simple, and that at Greenwich became its model.

The Observatory then was established by naval people for naval

purposes, and one of the first orders for its administration, which has ever been its guide, was that issued by the Hon. George Bancroft, Secretary of the Navy, dated March 6, 1846, as follows:

"Sir: Desirous that the numerous and able corps employed at the Naval Observatory at Washington may produce results important to maritime science and to the navy, I approve your course in making the series of astronomical observations necessary for the preparation of the Nautical Almanac. The country expects also that the observatory will make adequate contributions to astronomical science."

At about the time of the establishment of the Naval Observatory the Naval Academy there was founded for "instructing our young officers in the sciences connected with their profession," as Secretary Thompson put it in 1824. The Naval Academy was established to give to all officers of the Navy the education that heretofore only the most ambitious were able to obtain, thus affording a larger number on which to draw for the scientific work of the Navy. As has been said, there were practically no astronomers in the country at this time, and naval officers who in their professional requirements had to use instruments of precision, and who were already largely employed in the work of the Coast Survey, were about the only class to call upon for the Observatory's personnel. One of this number (Gilliss) was already a marked authority on astronomical subjects, and in fact, as Dr. Gould said, "He was the sole working astronomer in the nation."

The work of the Observatory was at first taken up by line officers alone, but with the completion of the organization of the Naval Academy at Annapolis, enabling the concentration of the several schools which were located at different naval stations, the corps of professors of mathematics who had been employed at them and at sea as teachers became available, and they were appropriately assigned to the Observatory, first as assistants, and eventually, upon the detachment of the executive officers for sea service, they were placed in charge of the various instruments, where they have performed faithful and conspicuous services ever since. But line officers have also always borne an important part in the astronomical work of the Observatory and contributed largely to the general results.

Notwithstanding it was Gilliss whose master mind constructed

the Observatory, it was not he who was assigned to its superintendence. He having reported, at the end of September, 1844, that the new building was ready for occupancy and the instruments adjusted, Lieutenant Matthew F. Maury, who had previously been assigned to the charge of the "depot of charts and instruments" on Capitol Hill, was directed on October 1, 1844, to remove all of its material to the site of the new observatory in the southwestern part of the city. Maury, who thus became the first superintendent, was the senior of Gilliss by about two years, and it is presumed that his seniority gave him this important command.

Gilliss, having completed for publication his observations made on Capitol Hill, and no doubt feeling sore at what he deemed an injustice to himself, accepted duty upon the Coast Survey under Professor Bache, who was ever ready to utilize the services of naval officers of scientific attainments. He was there employed in the reduction of the entire series of moon culminations previously observed and published by him.

Attention should be called to the fact that at about the time the Observatory was established, the Coast Survey, which had lived a precarious existence since 1816, was reorganized, and Congress directed on March 3, 1843, that "the President shall cause to be employed as many officers of the army and navy of the United States as will be compatible with the successful prosecution of the work." And again, June 17, 1844: "Officers of the army and navy shall, as far as practicable, be employed in the work of surveying the coast of the United States." This was done, notwithstanding the fact that the survey was under neither of the military departments. A similar provision of law had been made at the inception of the Coast Survey in 1807.

These various acts show the disposition of Congress to provide for a naval observatory and to utilize the services of naval officers for scientific work. This was, in fact, the only class from which to draw for its staff.

While Maury was building up the Observatory to the magnitude of the great institution which was soon recognized all over the world, Gilliss, smarting under the sting of seeing his labors going to enhance the reputation of his chief competitor for scientific honors, began to glean in other fields. With a letter from his friend, Dr. Gerling, the eminent mathematician of Marburg, as a basis, he planned an expedition for carrying on in South America

astronomical observations of Mars and Venus for the determination of solar parallax, which depended at that time solely upon observations of the transit of Venus in 1761 and 1769. He procured the small appropriation of $5000 from Congress, which was afterwards slightly increased, and selected the very site for his observatory where Dr. Campbell, of Lick University, is now operating an observatory with greatly improved appliances of recent development to investigate the motions of stars in the line of sight, a remarkable confirmation of Gilliss' good judgment. While the Gilliss expedition was not directly under Observatory control, it was a purely naval affair, and the Observatory was expected to, and did act in conjunction with it, by making observations at the home station, and the Observatory was expected to harmonize the work done by each.

I will not dwell upon the details of the observations made by Gilliss, for, as Dr. Gould says, "they are fully described in the magnificent volumes containing the results of the expedition."

The first officers attached to the Observatory in October, 1844, were Lieut. B. F. Sands (its superintendent from 1867 to 1874), Lieut. W. L. Herndon (who commanded the ill-fated ship Central America), and Lieut. G. H. Scott, with Passed Midshipmen J. L. Worden (of Monitor fame), R. H. Getty, J. M. B. Clitz, J. F. Stenson, W. B. Fitzgerald and M. K. Warrington. Later, between the dates of October 1, 1844 and July 1, 1846, the following officers were ordered to the Observatory:

Lieuts. T. T. Page, L. Maynard, D. D. Porter (afterwards admiral of the navy), W. B. Whiting (later chief of the Bureau of Navigation), and J. J. Almy; Professor J. H. C. Coffin, who had been a professor in the navy since 1838, and J. S. Hubbard and R. Keith, two young men just graduated from college; Mr. S. C. Walker also was appointed an Assistant Astronomer.

There is no question but that Maury laid out a stupendous scheme for the institution, which was no less than that of observing and cataloguing all the stars in the zone covered by the Washington telescopes, extending from 45° south declination to the farthest limits north. Maury has had to bear some criticisms for not accomplishing his object, which was, of course, an impossibility. But even Herschel himself, the father of astronomy, had to be content with much less than he set out to accomplish, which was practically the same ideal at which Maury aimed.

Maury started with an extensive staff for the "Naval Observatory and Hydrographic Department," as it was then called, but soon the demands of the hydrographic work became absorbing and perhaps more to his taste than pure astronomy. But for the first two years following his superintendency he was the principal observer with the equatorial instrument. After that, the expanding operations of the Observatory, which now began to take a high stand in the world of science, became all-absorbing and he found his hands full of executive work and left to his assistants the detailed observations while he conducted the institution to the high rank it has ever maintained. Followed in control by such men as Gilliss, Davis, Sands and Rodgers, its position was maintained as a matter of course. I need not repeat the story of successive administrations, but I must add my tribute to my old commander, Rear-Admiral John Rodgers, who prosecuted the scheme and procured funds from Congress for building the grand structure on Georgetown Heights, which now stands as a monument to his administrative and scientific ability.

It will be seen that the principal work of the Observatory is naval, the word being used in its broad acceptation as applying to ships in general but to the navy in particular, and I wish to emphasize this point. The Observatory is not, as has been said, "the nation's contribution to science." The numerous observatories in the country, which are supported by public-spirited men, come in this category; but the Naval Observatory, like its sister, the Royal Observatory at Greenwich, is practical in every sense of the word. As a writer has said of the latter, "First and foremost it is to assist navigation;" like Greenwich, the establishment of the Naval Observatory "arose from the actual necessity of the nation;" like Greenwich, "it was founded for the benefit of the navy and the general commerce of the realm;" like Greenwich, it has shared its work with allied sciences and contributed its full share of observations to astronomy in general as far as was consistent with the exigencies of the service. But in both institutions "assistance to navigation is now, and has always been, the dominant note in its management."

Up to the time of the separation of the Hydrographic Department from the Observatory in 1866, hydrography and astronomy shared its personnel. But before the transfer the importance of the former was so enhanced and had become so beneficial to com-

merce as to procure for Commander Maury the most distinguished honors at home and abroad. At his death this took the form of resolutions by commercial bodies of European countries, in favor, as they read, of "erecting a light-house on the Rocas Banks, off the northeastern coast of Brazil, to be named after Maury as a fitting expression of the world's appreciation of his services, and as reflecting credit on the governments which have united in this tribute to the goodness and greatness of the dead." But why, even at this late date, should not his own countrymen honor themselves by naming a suitable light-house in our own country after this distinguished scientist? If the Hatteras light is ever established, as it must be in time, it should bear the name of the "Maury Memorial Light-house" as a beacon to the commerce of the world at this most dangerous point of our Atlantic coast, and thus typify his immortal services to mankind.

There can be only one opinion as to what has been done for the commerce of the country as long as the Observatory was connected with the Hydrographic Department; but its great practical utility as an astronomical observatory is shown especially in its preparation of data for use in the Nautical Almanac.

A well-known writer has stated that in former times (before the days of astronomy) the dangers of navigation were so great as to cause the insurance on vessels to be about one hundred per cent of their value; in other words, the income from voyages at sea was all eaten up practically by the insurance agents. Commercial enterprises were therefore proscribed, except when undertaken by the crown itself, or by the great East Indian companies, whose exchequers rivalled those of the parent state. Commerce then could not exist but for the aids derived from astronomy. Without astronomy accurate charts could not be made, and the sailor would neither know when he was near his port, nor where his port was. An astronomical observatory is therefore an absolute necessity to the commerce of our country. The nation supports but one of these observatories at an annual expenditure of about $55,000. What is this sum compared to the billions of dollars invested in commercial pursuits? The Nautical Almanac gives the location of the "light-houses in the skies," as the stars have been appropriately called, which lead the mariner to the terrestrial light-houses of the coast and thus the vessel to a safe haven.

For years the United States Government had borrowed from

European countries, or rather taken from them their work "without a cent's worth of return in kind; without one observation made by authority." When the Observatory was established it took its share of the burden, and soon after, the Nautical Almanac Office being founded, our country through it made its contribution to this branch of science. The Nautical Almanac Office was established in 1847 under the direction of that distinguished sailor and scientist, Rear-Admiral Chas. H. Davis, then a lieutenant in the Navy. It is now a part of the Naval Observatory.

In a supplement to the American Ephemeris and Nautical Almanac for 1897 (page 42), on the "Elements of the four inner planets and the fundamental constants of astronomy," Professor Newcomb has given relative weights for the work of the principal observatories of the world. This record shows that in forming his Tables of the Sun, Professor Newcomb, who was then in charge of the Nautical Almanac, gave the data furnished by the Naval Observatory twice as much weight as that given to any other observatory in the world, except Greenwich; but in examining the numbers of Professor Newcomb's tables showing these proportions, it is found that while the Greenwich observations extend over a period of 142 years, the Washington observations extend over a period of only 45 years. Thus, while the Greenwich period is 3.16 times as long as the Washington period, the Greenwich observations are assigned a weight of only 2.45 times as great as those made at Washington. And this notwithstanding that for many years Greenwich has had an astronomical force from two to three times as large as that at Washington. In other words, according to Newcomb, considering the time it has been in existence and the force at its disposal, the Naval Observatory has contributed to the needs of the American Nautical Almanac, as exemplified in his solar tables, a weight of observations proportionately greater than that contributed by any other observatory in the world.

This tribute, coming from such a source, gives naval men a right to claim that its work has been well done.

It might be well to show the relation of the two branches of the Observatory—the Department of Astronomical Observations and the Department of the Nautical Almanac—to each other, and this will explain the statement of Professor Newcomb as given above. It should be understood that it is no more possible to correctly

"fix the stars" with observations taken at one station than it is to determine a position by triangulation from one point. It is the custom for many observatories to contribute into a general pot the results of their observations, to which are applied various systematic corrections incident to different localities, different instruments, and different observers, each being weighted for its peculiar characteristics and all harmonized into a standard catalogue. From these data the Nautical Almanacs are prepared for publication. Thus we get the special advantages of Greenwich in England, Pulkowa in Russia, Capetown in South Africa, etc., Cordova in Argentina to use in connection with and in exchange for the fundamental work done at the U. S. Naval Observatory.

Each Nautical Almanac is prepared for the navigation of all parts of the world, and is not circumscribed by the zone covered by the instruments of the individual observatories where they are published.

This makes it advisable for the different countries which publish a Nautical Almanac to agree on a list of selected stars, then each to make observations of that portion of the list covered by its own zone and furnish the data for the benefit of all. Such was the object of the conference of Nautical Almanac directors of the United States, Great Britain, France and Germany, which met in Paris in 1896 and adopted a list of 1597 stars, positions for which it is intended eventually to publish in the several almanacs controlled by those countries. At present there are 383 only of these stars listed in our own almanac, leaving, as will be seen, still a vast amount of work to be done.

In addition to such observations as are indicated above, the Naval Observatory is called upon to furnish star positions for the determination of terrestrial stations for such institutions as the Coast and Geodetic Survey, the Geological Survey, Surveys of the Army, &c., and in our own service for the various longitude and surveying expeditions which the Navy has so successfully inaugurated and carried to completion.

Of the 1597 stars agreed upon for publication as stated, 500 of them must be observed well to the south of the terrestrial equator where there are but few observatories making continuous observations, and hence it has been proposed to establish a small observatory at Tutuila, Samoa, which island is under the control of the Navy Department and is ideally located for such observa-

tions. The survey of the Samoan Islands, now going on under naval officers attached to the station, affords another important reason for the establishment of such an observatory. Here it is intended also to carry on magnetic work which is so essential to navigation and for which there is such a paucity of records in that part of the world.

It has been shown why the Observatory was established, and what the work performed primarily is for, but little has been said of what the work is.

The data required to prepare the Nautical Almanac can in the main be listed, but the incidental work which is to be contributed to astronomical science, as required by the constitution of the Observatory, is another matter.

It is well known that nearly all expeditions authorized by Congress for the observation of total or partial eclipses have been carried out under the general supervision of the Naval Observatory, in fact, most of them would not have been possible but for the assistance furnished by the Navy, except at a greatly increased expenditure of money. The observations resulting from these several expeditions provide data both for almanac tables and for contributions to pure science.

Another branch of the work is the observations of comets. This more particularly pertains to research, but yet such observations have a practical value, for they enter into the problem of the mass of the planets. For instance, Professor Newcomb, in his paper on astronomical constants, gives to the reciprocal of the mass of Jupiter derived from its action on Winnecke's comet, a weight of 10, the largest value derived from any source except that from Polyhymnia. All these data enter therefore as a positive factor in the tables of the Nautical Almanac. To illustrate the manner of procedure concerning such astronomical stragglers as comets, it might be well to take an example.

On December 3, 1902, at about 8 P. M., a telegram (in cipher) was received at the Naval Observatory through a central station in Boston, stating that a faint comet (d 1902) had been discovered at Nice, France, by Giacobini on December 2.396. The telegram having been deciphered, the observers on the two equatorial instruments of the Observatory were informed, and at 12h. 31m. W. M. T., or 31 minutes past midnight of the same day, near its transit, Mr. W. W. Dinwiddie discovered the comet in apparent

R. A. 7h. 17m. 24s. 81, and decl. 1° 50′ 3″.4 S. Mr. John Ritchie, at the distributing station in Boston, had transmitted the same message to all the principal observatories of the country, most of which immediately began to search for this straggler, and they vied with each other in early securing observations on which to base its orbit. Observations on the comet were also obtained by the Observatory on December 5, 7, 8 and 9. At Lick Observatory the comet was picked up on December 5, by Aitken, who also secured observations on the 6th and 7th of the same month.

On December 13, Messrs. H. R. Morgan and C. W. Frederick, of the Naval Observatory, had deduced from three normal places formed from these several observations the elements and an ephemeris, which were published in the Astronomical Journal of December 22, 1902. I would add that the young men engaged upon this work were complimented on their energy and precision by a number of astronomers of the country, as well as by their associates in Washington.

A mistaken impression regarding the Naval Observatory, which I have found even in the minds of some naval officers, I desire now to correct. It has been said that our Observatory has expanded far beyond the requirements of the Navy, being equipped with the most complete outfit of any observatory in the world, and hence should be given over to investigational work and administered by an eminent astronomer, the Navy contenting itself with a transit instrument, &c., to regulate chronometers. This is a fallacy in the minds of some and an argument without validity which has been used by designing persons to get control of the Navy's child by others. To particularize, it is said that the great 26-inch equatorial instrument, which has done so much to enhance the reputation of the Observatory, is not necessary to "fix the stars," which, as is stated, must be large enough to be seen by the navigator's naked eye, and therefore this large instrument is not a necessary part of the Naval Observatory's equipment. But is the navigator restricted to the "fixed stars" for determining his position at sea? Do not the sun, moon and planets enter into his calculations? The examination of any ship's sight-book will show that the solar system is largely in evidence and cannot be eliminated from the work. Now can an ephemeris of the planets be correctly prepared without data concerning their masses? Can the mass of a planet be computed without a knowledge of its compan-

ions or satellites? Could Hall have discovered the satellites of Mars, which had been searched for in vain for years, with anything but the largest telescope? There can only be one answer to these questions. The fact is that the request for an appropriation for the purchase of the 26-inch telescope was based on the necessity for an instrument powerful enough to observe satellites of the planets, and the Nautical Almanac could not be properly prepared without the knowledge derived from this instrument.

Such work as this is ordinarily carried on by national expenditures, and as the Naval Observatory is the only national observatory in this country the duty must devolve on it. Moreover, at the present time Washington is practically the only place in the country which is systematically investigating the subject of asteroids. The principal astronomical journal of the country, of late, has been full of copies of records from our files. A noted American astronomer has said of these records: "He (one of the observers) is doing valuable work in this field, and, in fact, the general activity of the Naval Observatory is something that astronomers must appreciate and take comfort and pride in."

The study of asteroids is particularly a Nautical Almanac subject, and as such is not undertaken by those observatories which have to deal with educational matters only.

It should be clearly understood that the Naval Observatory was established for purely utilitarian purposes, and its work is confined, as a rule, to the only branch of astronomy that has a practical application—navigation. When we realize that Greenwich came into being for the sole purpose of enabling the mariner to determine his position at sea, and that our own observatory was founded and expanded to its present grand proportions, by naval men, for the same purpose, after Congress had refused over and over again to allot money except for an establishment that would return a quid pro quo for the money expended, it seems almost incomprehensible that any one should claim that it was not necessary to the Navy. No fair-minded man exists that will not say, after an investigation, that it is first, last and all the time a Naval Observatory.

Committees in Congress have repeatedly stated that it should remain in the Navy where it originated. Three special boards which "investigated" it the past year have reiterated the fact that its work was purely naval, and, inferentially, that if it is not needed for naval purposes there is no reason for its existence at

all. This is because its purposes are utilitarian and not like other astronomical institutions in this country for educational purposes.

As further exemplifying the work of the Observatory, I cannot better present the subject than by quoting from the order covering the plan of work for the fiscal year ending June 30, 1904.

U. S. NAVAL OBSERVATORY,

WASHINGTON, D. C., JULY 10, 1903.

Order.

The following is prescribed for the general character of the work for the different instruments belonging to the Observatory for the twelve months ending June 30, 1904, or until otherwise ordered.

26-inch Equatorial.—Observations of the variable stars, X Hydrae, RT Librae, Z Capricorni, W Ceti; observations of double stars; observations of the satellites of Uranus in July and August, 1903, and May and June, 1904; observations of the satellites of Saturn in July to November inclusive, 1903, and June, 1904; observations of the satellite of Neptune in November and December, 1903, and January, February and March, 1904; observations of the fifth satellite of Jupiter, if possible; measurements of the diameters of the planets under favorable conditions; observations of such comets and asteroids as are too faint for the 12-inch Equatorial; photographs of asteroid fields with the Dallmeyer lens attached to the telescope; observations for instrumental constants once in three months.

12-inch Equatorial.—Measures of the distances of Jupiter's satellites, and observations of their phenomena noted in the Nautical Almanac, except from the middle of February to the middle of May; observations of occultations predicted in the Nautical Almanac, and others when possible; observations of asteroids and comets which are not too faint for the instrument; measurements of the diameters of the planets under favorable conditions; observations of double stars as time permits.

Meridian Instruments.—To make observations of the sun, Mercury, and Venus at every culmination whenever possible; of the moon at every culmination whenever possible; of Mars, Jupiter, Saturn, Uranus, and Neptune, when in the vicinity of the moon, to the extent of obtaining 30 observations of Mars, and 15 each of Jupiter, Saturn, Uranus and Neptune; of miscellaneous stars when requested; of a catalogue of 3000 zodiacal stars; when not interfering with the work above outlined, of α, δ, λ, and 6 Urnæ Minoris and of 51 Cephei, at both culminations, and of stars from Newcomb's Fundamental Catalogue.

Prime Vertical.—To make observations of α Lyrae at every possible opportunity; of θ Aurigae, α Canum Venaticorum, and μ Andromedae; of close zenith stars, under a somewhat improved method,—that is, direct and reflected, to be made possible by a change in the reticule of the instrument; to complete the list of 390 stars for improved declinations.

Altazimuth.—To make observations for latitude, of close circumpolar stars, above and below pole, observations of all the stars contained in New-

comb's Fundamental Catalogue that can be reached by the instrument, for improved declinations.

Photoheliograph.—Daily photographs of the sun, when possible, with temperature readings and scale settings; and preparations for future eclipse work.

C. M. CHESTER, Rear-Admiral, U. S. N.,
Superintendent Naval Observatory.

It is necessary to consider that practically all of this programme has for its main object the assistance to navigation, in other words, for the publication of a Nautical Almanac, which duty devolves by right on the National Government. Of this 97% of the results go into the construction of this publication, directly or indirectly.

It will be noticed that spectroscopy, heliography and astrography enter but little into the makeup of this plan, not as much, in fact, as at Greenwich. The line of demarcation between practical astronomy and investigational astronomy is so indefinite, however, that it is questionable if we could not carry on research work to a greater extent than we do. Several administrations have endeavored to cross the threshold into this field, and, in fact, a qualified promise to do so was made once by Lieutenant-Commander A. G. Winterhalter, U. S. N., when he was a delegate to the International Astrophotographic Congress, which was inaugurated by that distinguished scientist Admiral Mouchez, director of the Paris Observatory, and which met in Paris in 1887. While Mr. Winterhalter, by his orders, could not positively commit the Observatory to any programme of work, he did recommend that it should take its share in mapping the heavens by celestial photography, and this recommendation was heartily approved by the superintendent. Congress failed, however, to make the necessary appropriations, and the administration was debarred from making the contributions desired.

There can be no question but that astrography does come within the constitutional requirements of the Naval Observatory, but as it is necessary to show a return for the money expended, which is a difficult matter to do in scientific work, it is not always possible to get appropriations to carry it on. The administration has ever gone on the broad ground, however, that purely routine work of any kind can never be successful without investigational methods to keep it up to date. This calls for a limited amount at least of research work to keep our people in training, if for no

other purpose. Moreover, investigational astronomy is so fascinating as compared with the drudgery of ordinary navigational astronomy, that it is necessary to devote some time to problems of this kind in order to keep up one's interest. By such means also a better class of people can be kept on the Observatory rolls. There are many astronomers of repute, who began their life work here, now reaping the benefits of their early studies at the Naval Observatory.

It should be remembered that the Naval Observatory originated in a "depot for charts and instruments," and that the astronomical department was an addition to this depot; that while the Department of Charts which grew under the skilled hands of naval officers to such proportions as to make a separate department of it necessary, there still remains in the Observatory the Department of Instruments as well as the Department of Astronomical Observations. The former has also grown to large dimensions, owing to the great increase in the naval service; so large, in fact, that it has been necessary to distribute the work under it between two departments; one the Department of Nautical Instruments, the other the Department of Chronometers and Time Service. These two departments of the Observatory alone have heretofore kept employed from five to six naval officers, who were assigned to this duty as an alternate to their sea duty. The Department of Nautical Instruments has cognizance of the purchase, inspection and care of all the nautical instruments belonging to the navy, except chronometers, and at the present time handles nearly $100,000 worth of navigation implements per annum.

The sister department speaks for itself. Not a day goes by but that many thousands, if not millions, of people set their watches by the click of the clock in this department's wing of the Observatory building. The clock, regulated by the transit of stars practically on every clear night, is attached, through the vast network of telegraphic wires which bind together the innumerable stations from the Rocky Mountains to the eastern borders of the land, to some 50,000 sister clocks in the Western Union system alone. And at each day, noon, in nearly every telegraph office of the country, you may learn the time to the tenth of a second.

This time service has been brought about by a process of evolution. Beginning with small experiments carried on as early as 1816, when one Rolands, an Englishman, connected two clocks

together with some 500 feet of wire, really for the purpose of distributing electricity rather than that of distributing time, it has grown to enormous proportions. As in the astronomical work, a naval officer was the first to carry out the practical idea of transmitting time from point to point. The officer referred to was the late Rear-Admiral Wilkes, who built the first observatory of the country on Capitol Hill. Hardly had Morse finished the first telegraph line connecting Baltimore and Washington on the 27th of May, 1844, when Wilkes began exchanging signals between the two cities for the determination of their difference of longitude. On the 12th of June, only two weeks after the line was completed, he had, by the use of two chronometers, determined this difference of time within 0.03 of a second of the final results obtained by the Coast Survey with the chronograph. Later, Dr. John Locke, of Cincinnati, an ex-naval officer, perfected an instrument for automatically delivering time signals by telegraph, and, with an appropriation of $10,000 secured by Maury, superintendent of the Observatory, built a clock with chronographic attachment. On the 7th of December, 1849, this clock was placed at the Observatory, where it now stands as another monument to the scientific ability of naval officers.

The necessity of giving the time of mean noon to the navigators and others in New York harbor and other distant places soon gave improved methods for its distribution by electricity and for dropping a time-ball from some prominent tower. When the fire alarm service was established in Washington, it suggested itself to the Observatory staff that the wires connecting the Observatory with the fire alarm tower could be used to send out observatory time to the then distant central part of the city. The municipal government immediately saw the advantages of such a scheme, and the superintendent having bought the necessary plant, in August, 1865, the fire bells began to strike the time daily at 7 A. M., noon, and 6 P. M. The State Department, which was then temporarily housed in the Orphan Asylum building on 14th street, had a special wire running directly to the fire alarm office. Upon the request of its officers that the time signals be sent to them over their special wire, this department was also brought into the circuit. The Western Union Telegraph Company also had wires in the State Department building, and their operators almost immediately fell into the habit of transferring the signals from the

fire alarm wire to their own lines and sending them to the main office of the company in Washington.

From these small beginnings grew the enormous service which carries the time from Washington to all parts of the country, and gives to the public one of the greatest benefits of the age. At the suggestion of the Observatory the telephone companies are now assisting in this daily distribution of correct time, and this system is extensively used by the busy men of Washington.

An interesting plan was inaugurated in January, 1903, of sending out telegraphic time signals to mark the exact instant of the beginning of the New Year. In Washington and at other points the time-ball was dropped at midnight, illuminated by an electric search-light, exactly as it is ordinarily dropped at noon. The telegraph companies took up this idea with marked interest and through their hearty co-operation a New Year's greeting was transmitted January 1, 1904, throughout the United States, Canada, Mexico, and as far as the wires reach in Alaska; to Lima, Valparaiso, Buenos Ayres, Honolulu, Guam, Manila, Sydney (Australia) and Wellington (New Zealand); and to Greenwich, England; and but for the greatly increased business of the European and Asiatic lines incident to the war scare in the far east, it is believed our midnight signal would have completed the circuit of the globe.

The interest in this scheme has been so universal that it is believed that another year will witness the consummation of an all-around the world announcement of the beginning of our Happy New Year. So perfectly were the connections made on the different relays of the Western Union Company that the Lick Observatory in California received the midnight signal from Washington after an elapsed length of time of only 0.06 of a second.

The usual series of signals was sent out, begining at five minutes before the hour, omitting certain seconds to mark clearly each 30th and 60th second, the final click, after a 10-second interval, marking the exact instant of midnight. The series was repeated at 1, 2 and 3 A. M., as a midnight signal for those using Central, Mountain and Pacific standard time, respectively, in order that every section of our broad land might receive its own signal directly from the Naval Observatory. It is thrilling to think of these successive series of midnight signals, that cold clear New Year's Eve, flashing over countless thousands of miles of wire to nearly every telegraph

office in the land, and many in far distant countries of the globe, at practically the same instant it was sent. And thus was made audible over a large area of the world every swing of the pendulum of our standard clock as it counted out, in its quiet, solemn way, the last moments of the dying year.

This is one of the practical things which naval officers have given to the country in return for the scientific education so generously bestowed upon them at the Naval Academy.

I might here refer to another practical idea which may be said to have emanated from the Naval Observatory. The Weather Service of the United States owes much to the late Commodore Maury, first superintendent of the Observatory, for its inception. When in the full flush of the success of his great system of meteorological observations at sea, he urged the necessity of having the system extended to the land. "In my humble way," said he, "I have been advocating the establishment of a similar system of weather reports and telegraph warnings not only for the shipping, but for the farmers also of the United States."

And here I want to state that the prevailing opinion outside the service that naval officers should be employed at sea and let landsmen only do the shore work is fallacious. The Naval Academy was not established to make seamen only, for experience supplemented by the limited education given to officers in other navies until recent date produced the best of seamen. Our policy, however, has been to select our young officers from the thousands of applicants all over the country and to educate them not only to man and manage ships, but how to build them as well. Our officers inspect the steel that is made from the ore from the mines; they test the plates which go into the hull of the ship; they make the guns which compose their armament; they plan and install the electrical plant which manipulates the various devices which save to the Government an average of 200 men in each of our large ships as compared with sister ships in foreign countries; they plan and superintend the installation of the machinery; they equip the ship with the nautical instruments which insure the safety of our $5,000,000 ships as they cross the ocean. These duties make a vast postgraduate course for the alumni of the Naval Academy, and utilize nearly one-half the complement of our officers except in time of war. Can it not be said that these duties are nearly as important as those required at sea except in time of war? That this disposi-

tion of officers was intended by Congress is shown by statute after statute; for example, "As many army and navy officers as practicable shall be employed upon the survey of the coast of the United States;" and as indicated in the bill which gave to the Navy the Naval Observatory. In fact, in the annual appropriation bills during the early years of the Navy, specific items for pay were inserted for officers at each of the shore stations, including the Naval Observatory, receiving ships, &c. In 1847-48 Congress failed to make any appropriation for the Naval Observatory whatever, and in consequence the superintendent's (Maury's) pay was stopped for a time. And furthermore this is good policy, for we have, when the complement is up to the standard, more officers than are required for sea service during peace times, while the full quota is necessary in times of war. In fact, in all of our wars since the Navy was established we have had to improvise officers when war began, but I think the most bitter opponent of the Navy sees the impracticability of such a scheme for the future. I would like to point out what occurs to me as an argument in favor of a liberal supply of these officer students at the Observatory. We must remember that navigation, pure and simple, cannot be carried on as it was even 25 years ago. Ships are now valued at millions of dollars where formerly thousands covered their cost, and their insurance is a matter of great importance. Moreover, they steam at much greater speed than formerly, and this adds to the danger of their voyages. Then an observation of the sun for longitude in the morning and another for latitude at noon summed up about all that was required in navigation. Now a good navigator will begin his day's work before sunrise, with observations on at least two of the "light-houses" sparkling in the heavens; indeed, he will generally have had several observations during the night as well; and he is not a first class navigator if he does not have five positions of the ship charted before the hour he usually plotted but one. Five points on a line, be it straight or curved, determine its position and in navigation insures the safety of the ship. This scientific navigation is brought about by combining the practical work at sea with the theoretical work given to our officers on shore.

One of the officers who was employed for several years in the Naval Observatory (Nautical Almanac Department) has written the standard work on navigation used in the service to-day. He

could not have done this had he been employed continuously at sea. There is no class of officers in the world called upon for so many important duties as ours, and it would be suicidal to curtail their preparation any more than is absolutely necessary to man our ships. The Naval Academy then is our only salvation, and not even the requirements of the fleet should interfere with its progress, and with the important post-graduate courses that have made our naval officers and our Navy what they are to-day.

Another specious argument that has been used to the disadvantage of the Navy I desire here to consider. The question is this—that if the Naval Observatory was designed to assist navigation both in the Navy and in the general commerce of the country, which bear the proportion the one to the other of about 1,000,000 to 4,000,000 tons of ships, why should not its control be turned over to the larger interests, say to the new Department of Commerce and Labor? This has been answered by the statement that while this proportion as to ships may exist, yet, as the United States has practically no foreign commerce carried under the American flag and as the coasting trade, of which this 4,000,000 tons mainly consists, practically requires a knowledge of coast navigation only, which is very different from deep-sea navigation, the paramount interests of the Government as regards astronomy center in the American Navy. Furthermore, as it requires a scientifically trained seaman to handle this important subject—one who not only can use the data but understands the science—the navy list is the only source from which to draw such administrative ability and therefore the Navy should have its control.

The Naval Observatory may be considered the great insurance house for the Navy, the Government itself being the insurance company. From it are furnished the delicate navigating instruments belonging to the service and the necessary information to handle them. These instruments in the hands of trained experts keep our ships away from dangerous coasts and insure them against accident with a less percentage of loss than that for any other navy, and indeed for that matter, for any other business where comparative risks exist.

But few of the many million people who traverse the broad Atlantic from the United States to Europe realize how immune from danger are their voyages owing to the study and development of the great steamship lanes of ocean traffic originated by

that eminent scientist Commodore Matthew F. Maury, the first superintendent of the Naval Observatory. Nor does the Navy itself stop to think in these strenuous days of naval development how much they owe to that distinguished astronomer, the founder and second superintendent of the Naval Observatory—Commodore James Melville Gilliss, U. S. N.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE CAMP OF SANITATION AT LEAGUE ISLAND, 1903.

By REAR-ADMIRAL CASPAR F. GOODRICH, U. S. Navy.

So many officers have urged me to give to the service, through these pages, an account of the manner in which the camp of sanitation was established on League Island in the spring and early summer of 1903, that I have felt obliged to yield to their instances and to go even beyond what was asked by telling of our mistakes and failures as well, for it is quite as much in this way as through success that we acquire knowledge. To know what to avoid is, sometimes, the larger half of wisdom.

The necessity of such a camp suggested itself in April or early in the month of May to the officers in the Bureau of Navigation who were naturally alarmed by the persistence on board the receiving ship Minneapolis of three forms of contagious disease, viz: mumps, measles and cerebro-spinal-meningitis, the latter of a most virulent type. It is well at the outset to say that troubles caused by overcrowding the vessel had been foreseen by the authorities at the yard, who had made proper representations to Washington so early as the preceding September and had given due warning of what might be expected. The conditions of recruiting, etc., were, however, beyond the control even of the Navy Department, which exerted itself to lessen, and did somewhat lessen, the difficulty but in spite of all its efforts there were times when at least twice as many men were packed on board the Minneapolis as she could properly care for. The task before the commanding and other officers of that ship was to help the Department in every possible way especially through scrupulous attention to the details of hygiene, so that the necessary *sequelæ* of an unavoidable overcrowding should be reduced to a minimum. All this was faithfully and loyally done. I think we have more reason

to congratulate ourselves upon the small number of cases of disease than to reproach ourselves with the instances of fatal ending.

Except in the most violently inclement weather that season, the men were kept in the open, drilling or at sports, practically all day. To relieve the congestion below decks at night, as many as could be accommodated there were made to sleep on the upper deck, sheltered by awnings and side curtains, a bleak and raw dormitory, but at least abundantly supplied with pure air.

To be sure, coughs and colds prevailed but these were preferable to the maladies which attend the assembling of men in restricted quarters. It is a curious and humiliating fact that there seems to be nothing in the world so dangerous to man as too many of his own kind. Mumps and measles, like the poor, we had always with us and we always cherished the hope that each case would prove to be the last—only to be disappointed as fresh attacks declared themselves. Mumps and measles, as a rule, are annoying rather than serious so we bore the infliction patiently, looking forward to the coming of spring with its double promise of balmy weather and the relief of the strain through sending a large number of our recruits afloat in the Yankee. Unfortunately, the spring brought us something we did not desire, the contagion of spotted fever, as cerebro-spinal-meningitis is commonly called. The first case has been unmistakably traced by Surgeon Chas. F. Stokes, U. S. N., to an infected house in the town of York, Pa. Poor fellow, the victim is no longer alive to regret the fatal gift he passed so generously to his shipmates.

The early instances of spotted fever were ghastly in their violence. One moment a man would be feeling quite well; the next he would drop in his tracks as if struck by a club. A high fever, severe pains in the back of the head and neck, vomiting and mental hebetude at once combined in a diagnosis which could not be questioned. To the hospital he would go and in forty-eight hours his remains would be buried on Mount Moriah—or else he would linger and gradually recover, a wreck in mind or body or both. Death seemed indeed the kindlier fate. The cases soon began to be of a milder type and towards the end of the epidemic the recoveries were so many that the total mortality was reduced to about 35 per cent.

As I have already said, the suggestion of a camp came originally from the Bureau of Navigation and was at once welcomed

and accepted at League Island. Some thirty-five hospital tents were quickly obtained from the army. These tents are about fourteen feet square and they hold twelve persons each, comfortably. They are wall sided and having a separate fly securing air space and double roof, they are as cool in hot weather as is possible. To the original number a hundred more were soon added providing, in all, ample accommodation for about fifteen hundred men.

About this time the superstructure, the principal berthing place of the Minneapolis, was vacated absolutely and temporary use made of the Puritan—a ship lacking in all the requisites for a receiving vessel, but at least as yet, uncontaminated. Later on, the Minneapolis was put out of commission altogether and her place taken *nominally* by the Puritan. I say " nominally " for the ship only furnished quarters for the officers and their messes—and the heading of official documents. Practically all the work and all the men were transferred to the camp.

Having received orders to establish what was known as " Camp Minneapolis " or " Camp Goodrich," when it was not jocosely referred to as " Camp Meningitis," my first care was to enlist the best advice and assistance at my disposal. Fortunately the officer commanding the Minneapolis' marine guard had had much and varied experience on the march to Pekin and he had but just returned from Culebra where he had spent the previous winter in building the camp on that island. I drew upon him for all the theory he had imbibed through study and for all the practice which had fallen to his lot in the field. Moreover, the camp being a military affair, I took a leaf out of the army's book and appointed him my camp adjutant. And this is as good a place as any to bear witness to the invaluable help, through counsel and action, rendered me by Captain Smedley D. Butler, U. S. M. C., and to his energy, tact and hustling, which brought about results without friction and without delay. Without such a combination of knowledge and capacity on his part my task would have been difficult in the extreme and vastly longer in the execution. While claiming some small personal share in the plans and routine, I must confess the magnitude of my obligation to my adjutant and to the other officers of the Minneapolis who worked like beavers in this unaccustomed sphere. Lieutenants A. T. Long, J. H. Rowen, J. R. Y. Blakely, H. A. Pearson and O. G. Murfin were especially instrumental in compelling success, enduring great personal discomfort

in so cheery a manner that I was, at times, almost tempted to think they really liked their new surroundings. I was exceedingly fortunate in possessing, at my command, the indefatigable attention to duty, the intelligent grasp of the situation and the skill and loyalty of Surgeon Clement Biddle, U. S. N.

I may also say that everything official was done which could have been done. The Department and its bureaus acted promptly on all requests and requisitions and they gave unsparingly of their funds.

The first problem was the selection of a proper location. The choice was necessarily restricted by the conformation of the ground, for League Island is almost wholly artificial. Many years ago, retaining dykes were thrown up on the reedy marsh which bore that name, to enclose large areas of shallow water and sand banks. Into these areas was poured and pumped the soil brought down in barges from the dredging operations at Smith's Island in the Delaware, off Market street, Philadelphia, so that League Island may be said to be Smith's Island transplanted. Obviously land thrown up in this manner is not likely to be very "accidentée," and in fact League Island is so flat that our only solicitude was in finding a space high enough, in general elevation, to yield even a moderate surface drainage towards the Delaware river on the one side and towards the back channel on the other, while large enough for the pitching of a hundred and thirty odd tents. In other words, the first essentials in a camp site are natural surface drainage away from the camp and secondly, elbow room.

In this case we were lucky enough to obtain what was wanted in close proximity to the twenty acre drill and recreation ground which I had been able, thanks to the Chief of the Bureau of Yards and Docks and to the voluntary manual aid of enlisted men from the receiving ship and the marine barracks, to create out of the jungle of bushes, weeds, scrub willows and poplars set in sandy reaches and about marshy places and small ponds, which, so late as September, 1901, when I first went on duty at League Island, had flourished in rank luxuriance quite up to the officers' quarters, the undisturbed home of the wild rabbit and the fierce mosquito and a constant menace to dwellings and shops, should a forest fire spring up with a fresh wind blowing home. The benefits of this drill ground proved to be beyond characterization. Here were the recruits drilled, their clothing

and hammocks aired and inspected; here were base-ball diamonds, foot-ball parallelograms, hurdles for racing, etc., etc., and tempting plats of grass for loafing and dreaming of friends and relatives far away or of the strange lands and stranger peoples that the future was about to make familiar to the greenhorn. The task of turning a wilderness into a grassy meadow had at first seemed beyond our powers, but by persistently grubbing up roots, filling pools, smoothing out rough places, cutting down shrubs and weeds, flattening out with a heavy roller; occasionally (if too infrequently) mowing the grass with the scythe, the farm machine or the horse lawn mower, and by subsoil draining, at first through rude stone-filled trenches in whose plan and execution Chief Gunner C. B. Morgan had profitably employed the superfluity of his exceptional zeal, and later by tile piping supplied by Yards and Docks and laid by our own men, a splendid sailors' field had been constructed, possibly the best the navy possesses.

The nature of the terrain next claimed our attention. We chose a spot where sand and gravel alternated so that when it rained, the water might be quickly absorbed, leaving the camp streets dry at all times. In the orientation of the camp the streets were designedly pointed to the prevailing winds so that the latter should have a full and unobstructed sweep. As this was to be a camp of sanitation, it was imperatively necessary that no stray microbe should find shelter from the light and the air, his deadly enemies, upon whose ministrations we depended for success in our battle with disease.

It was a comparatively small matter to fell the trees, dig up the roots and shrubs, mow down the weeds and grass at the camp site, and even to extend the clearing to cover a margin of a hundred yards or so beyond; and with this we expected, in our ignorance, to be content, save that we always meant to open up the ground towards and as far as the river to the front, and to the Back Channel to the rear, in order to allow the wind to pass through unimpeded, and along that line to spoil all lurking places for mosquitoes. Later on—indeed very shortly—we realized how short-sighted we had been. The hundred yards margin was first extended to two hundred yards and then further yet until it finally met the cleared portion of the navy yard at the west and, in the other direction, until it covered the extreme end of

League Island. Moreover, every bush and shrub growing along the shores of the river and the channel was pulled up or cut down. Excepting a very few large trees, left for shade, here and there, League Island was bared from the drill ground to East Point of everything but grasses and such other vegetation as closely hugs the ground. There was no alternative, this work had to be done. And when my readers in their turn establish their camps they will have to follow my suit or, like me, they will find the musical and too sociable mosquito a permanent and multitudinous tent-mate dividing the spoil in some parts of the world, with the jigger, the borachuta and other unpleasant and malignant little pests; and they will find, also, that men revert but too rapidly and easily to the customs of their early progenitors, who lived in caves and ate roots.

The enlisted men in Camp Goodrich were a very decent, well disposed and well behaved lot, but Digger Indians could not have shown less regard for the simplest rules of hygiene. The nearest fringe of bushes became, at once, a screen behind which were dropped and thrown odds and ends of food, dressings from wounds, old shoes and garments, human excreta, etc., etc. It was impossible to post enough sentries to prevent the slipping out of sufficient careless or mischievous persons to foul the whole neighborhood. This is not an isolated example; quite the contrary. Our modes of living are purely conventional. Once the restraining influences are removed of our surroundings, material and personal, the average man falls back into the elemental instincts of the race. Moralists and novelists without number have observed this curious sociological phenomenon and have even remarked that, the higher the plane departed from, the lower the depths to which the plunger is carried. In commenting upon this particular illustration, Rear-Admiral Sigsbee, the commandant at League Island, recalled the shocking ways of the regiments landed in Annapolis in 1861 on their way to the front and the fact that the most shameless nuisances were committed by men from the cities—to speak more exactly, city men rather than mechanics or countrymen. If I have dwelt upon this unsavory subject at some length and with especial emphasis, it is in order to impress upon my readers certain conclusions drawn from my experience (and that of wiser men than I am).

(a) The wider the margin of absolutely open ground about

THE CAMP IN COURSE OF ESTABLISHMENT. ON THE LEFT THE SURGEON'S OFFICE AND VIEW TAKEN FROM THE TOP.

a camp the less the difficulty of keeping men within bounds and of policing the site.

(b) Even in these days, men are but natural men, after all, and they will toss aside scraps of meat, crusts of bread, an old sock, a rag from a sore, dressings from a wound and they will micturate and defecate wherever the humor leads them, each one saying to himself, "The little I do won't make any difference," forgetting that there are a thousand others whose combined efforts speedily achieve colossal results vastly disagreeable and extremely dangerous.

(c) We must therefore make our latrines commodious and comfortable that men may have no temptation or excuse for committing nuisances; and the latrines must be so near as to make a trip to them less of a burden and a bother than to seek the shelter of the adjoining jungle.

(d) We must, as I did, establish a patrol through the neighborhood of the camp to keep the men in bounds and to arrest all stragglers, not excepting those who disobey the sanitary orders. The latter had finally to be treated with great severity and any man even so much as "pumping ship" outside the latrines was liable to trial by a summary court-martial.*

I learned then, what possibly some officers may not know, that typhoid and like germs can be disseminated in the urine.

Our first latrines were of a simple but approved field type—perforated barrels sunk into the sand under a rude but not uncomfortable cross-piece. Earth, sand or ashes were thrown in after each using. When the barrels were filled they were lifted out and they and their contents burned up. I cannot say that the arrangement worked to my complete satisfaction. It was effective, to be sure, but it necessitated infinite care in supervision and a world of trouble in disposing of the night soil. For an inland camp I should hark back to the old practice of

**Special Order No. 6.* JUNE 12, 1903.

Any man discovered committing a nuisance in the camp will be tried by a *Summary Court Martial.*

By order of CAPTAIN GOODRICH.

SMEDLEY D. BUTLER,
Captain, U. S. M. C., Adjutant.

N. B.—All camp orders were issued in this form. For brevity the signatures are omitted from the others quoted in this article.

digging very deep trenches in sandy or gravelly places and when filled to within three feet of the surface, throwing in loam and dirt, burying the stuff for all time. At League Island this plan was forbidden to us, for a hole three feet deep would invariably strike water. Luck favored us again. At the Delaware River front of the camp was a rickety abandoned dock reaching to deep water. At slight cost the dock was strengthened and upon it were built overhanging privies of abundant capacity—a small one being reserved for the sick and a larger one for the "suspects," of whom you will shortly hear more. That problem, almost the gravest touching camp life, was solved. I may remark that white wash must be frequently applied to the *inside* of the chute under the seating. Flies are very active carriers of germs in fæcal matter, as our army friends know to their cost, and the only safety is aseptic cleanliness.

Probably I have not made it clear to my readers that our plans were two-fold in nature. At first, the object was to hurry the men ashore from the infected receiving ship and get them under canvas as soon as possible, somehow,—anyhow; later the thing resolved itself into establishing a permanent camp where they could stay until winter. This dual feature of our task, if kept in mind, will account for some apparent duplications of work; some seemingly inconsistent gropings.

As with the latrines, so the kitchen. We set up, in the open, four field ovens of the Boosicott pattern, drawn from the Quartermaster of the Marine Corps, which served us quite as good meals, and certainly quite as hot, as those from the ship's galley. Although only designed for about 20 to 25 men apiece, we had no difficulty in forcing them to cook for 35 men each. They are in all respects admirable. A large and commodious cook-house was rapidly built and installed with ship's galleys. When completed, the Boosicotts were abandoned for the larger, more convenient and more permanent ranges. To the latter were added steam coppers and coffee boilers, an old boiler of small size being resurrected from the scrap heap by the camp adjutant and dragged to the neighborhood of the galley where it was mounted, coupled up and covered in with a rude shanty. Prior to that, and as a temporary measure, a hoisting engine and boiler belonging to the accommodating and opulent Department of Construction and Repair, had been used for a short time; until the

SICK QUARTERS. ON THE RIGHT THE MESS HALL GOING UP, AND THE GALLEY LOOKING TO THE SOUTH AND WEST.

brief limit of its capacity had been reached. To feed the boilers, wells were dug in the ground which yielded an ample supply of soft water at a short distance below the surface.

For potable water we depended upon the yard system. (This water is pumped from extremely deep artesian wells and into a large distributing tank raised on a platform high enough to send it into the upper story of any building on the island). A pipe 1½ inches in diameter (I think) was laid by Yards and Docks underground from the nearest point of the system—some 1500 feet away—and fitted with faucets at the camp end. Eventually, this pipe had no faucets outside the cook-house except one, under a sentry, which served as a scuttle butt. Since no factor enters more largely into the question of health than drinking water, we were fortunate in having our supply ample in quantity and of irreproachable quality. It contained no vestige of organic substance, not a single microbe and only a little inorganic matter, mostly common salt. While on this subject, I cannot refrain from expressing a wish that our ships carried, each, a due proportion of the "boat distillers" that were once a part of every launch's equipment. Compact, simple, efficient, there is no reason why, having them, a landing party from an American man-of-war should ever fear cholera, typhoid fever, or any other intestinal disease attributable to bad drinking water. And I am not sure that the army does not need them, quite as much as the navy. They would have been of priceless value at Santiago.

To carry off the dish water and the other slops, washing water, etc., a glazed terra-cotta drain-pipe of 8 inches bore was laid with a uniform pitch from inside the cook-house to the nearest point of the sea wall on the Delaware River. A branch opened just outside the house, and both led into a large grease trap which then delivered into the main drain. Strict orders were issued and enforced limiting the use of this drain to fluids containing no solids and little or no grease. It was not meant to be employed as a lazy man's appliance for disposing of liquid garbage.

The wastes of the camp gave us at the outset, great annoyance and concern. The least negligence at any point was marked by clouds of flies which came from no one knows where and settled even upon the spot in the sand where a cup of coffee had been carelessly spilled. It seemed absolutely impossible to

beat into the heads of the men the comprehension that their own comfort and safety depended upon each one's doing his utmost to keep the place free of flies by at once, and in the manner prescribed, disposing of the material upon which the flies fed and throve, but, in the end, by reproof, by discipline and by making *the right way the easy way* we finally achieved a notable success. For the methods employed I claim only that credit which is due the man who has wit enough to profit by the advice of the ablest expert in the art. The late Col. George E. Waring, Jr., a great personal friend of mine, was wont, when my good fortune brought me within his "sphere of influence," to discuss this matter fully and clearly. His enthusiasm led him to predict that, in the case of New York for example, the city's wastes would, eventually, prove the city's profit. Time, by the way, has made this prophecy good. On one point he dwelt with the emphasis of repeated and incessant reiteration. "Don't mix your débris," he would say, "keep each kind by itself." I believe Colonel Waring would have approved the methods adopted in our camp to carry out his ideas. Briefly, these methods provided for the separation of each variety from the others, for their prompt, frequent and regular elimination and, most important feature of all, the responsibility for cleanliness was localized, a certain person being individually answerable for each square foot. This focusing of responsibility is exemplified in

Special Order No. 11.

"Chief Master at Arms O'Keefe will, hereafter, have complete charge of the policing of all the ground in the rear of the camp including the kitchen, mess tables, garbage barrels, drains and wash boards."

Moreover, a careful sanitary inspection was made every day by the surgeon, who reported in writing the results of his observations. That is to say, not only was X to have the place cleaned, but Y had to state that X either had done so or had not done so. The following orders were issued and put into force:

General Order No. 5.

Upon the prompt disposal of refuse and garbage depends the health of the camp. It is therefore enjoined upon all persons in the camp to faithfully and strictly carry out the provisions of this order, each doing his appropriate share towards the maintenance of correct sanitary conditions.

The refuse may be divided into the following classes:

A. Paper and other litter that can be burned.

B. Bottles, tin cans and other things that can not be burned.
C. Ashes.
D. Solid garbage.
E. Liquid garbage.
It is forbidden to mix these classes:
A. Combustibles, will be accumulated in tin cans marked "A" in special order No. 4. One at each tent and one at each building.
B. Incombustibles, will be similarly accumulated in tin cans marked "B."
C. Ashes, will be distributed about the camp according to the instructions given from time to time by the Camp Adjutant.
D. Solid garbage, will be scraped off the plates or tables by the mess cooks, or gathered by the galley cooks, and put into barrels for the purpose, marked "D."
E. Liquid garbage, such as coffee, soup, and so forth must be kept separate from all other refuse. It will be put into barrels marked "E," and will be wheeled to the Delaware and thrown into the river at 7.30 a. m., 1.15 p. m., and at 5.45 p. m.
The officer of the day will execute this order and will see that no garbage is left in camp after 6.30 p. m.

A chief master-at-arms was charged with the execution of item D, a boatswain mate 1st class, with that of E.

The solid garbage was removed three times a day. A farmer nearby had the privilege of taking away whatever he needed for his hundred or so of hogs, and the balance was burned in the yard "incinerating plant," a most useful institution.

Inedible refuse was accumulated and handled in accordance with the following:

Special Order No. 4.

THE TENT CAPTAINS AND OFFICERS IN CHARGE WILL EXECUTE THIS ORDER.

1. Each tent and each building will be provided with two tin cans to be used for scraps. One for combustible substances and one for incombustibles found in and around the tent. When full they are to be emptied into the barrels at the ends of the streets.
2. The can for combustibles will be marked "A" and will be kept at the N. W. corner of tent, that for incumbustibles marked "B" and will be placed at the S. W. corner.
3. The barrels will be emptied each morning and returned to their respective places.

and

Special Order No. 6.

All combustible refuse will be burned every morning in the rear of the camp.
All incombustibles will be removed to the Incinerating Plant.*

*The Navy Yard authorities took charge of incombustibles at this point. They were used for filling in.

Under ordinary conditions of service, incombustibles would be buried in wide and deep trenches, the fresh dirt from the extension of the trench being thrown upon the débris, thus "digging and covering" as you go. As much of the incombustible stuff has particles of grease and food adhering, the quicker it is interred, the fewer the flies.

The surgeon's task is defined in

Special Order No. 10.

In order to insure prompt and complete removal of garbage and to maintain sound hygienic conditions in camp, the Surgeon will make a daily sanitary inspection of the kitchen, garbage receptacles, latrines and their surroundings, and will report, briefly, in writing, each day, the result of the inspection. His special scrutiny will be required at the Sutler's tent and at other points where food refuse accumulates.

There is no purifier like fire. Whatever of our débris could be burned was burned in fires built morning and evening at the ends of the camp streets, while the surgeon had his own little crematory for rubbish, lint and dressings.

A constant supervision was maintained over the site to prevent the careless tossing aside of scraps of food, etc., and the greatest care exercised in connection with the garbage. The latter was frequently collected in large barrels, marked "D," placed upon a tarpaulin well to the rear of the camp and fitted with fairly tight covers. The barrels inside and out, and the covers were whitewashed after each emptying, that is, three times a day, and dry quick lime and carbolic acid were strewn and sprinkled with liberal hand every day about the site of the garbage receptables. Before these radical measures were adopted, the flies were like a plague of Egypt for number and the odors were strong and far-reaching. After that, the former largely disappeared and the daintiest nostrils were not offended even by close proximity to the garbage casks. For field service, I urge that the amount of solid garbage be kept to a minimum by strict attention to the quantity of food issued. Too great a percentage of garbage means an excess of provisions. Cook what is necessary and chuck the balance of the rations into cauldrons to simmer down into soup. Those of us who have travelled know how economical and toothsome is the Frenchman's *pot-au-feu*. "Our witty neighbor, the Gaul," as Mr. Micawber liked to call him, throws away practically nothing but the bones,

and yet, when we wish the best table in the world, we hire a French *cordon bleu* to reign over our kitchen. A certain amount of food waste is unavoidable even after the greatest precautions and closest calculations. My recommendation is to drain it of superfluous moisture and then burn it.

At the same spot where the solid garbage was accumulated, we stood up the liquid garbage barrels, marked "E," closely covered, likewise on tarpaulins, and likewise white-washed and carbolized at regular intervals. A special little dock overhanging the Delaware River was constructed by the Department of Construction and Repair. Upon this dock the E barrels were taken three times a day and dumped. At first, we had to transport them in push carts but subsequently we got barrel trucks, screwed trunnions to the barrels and without touching the latter by hand, engaged the trunnions in appropriate jogs left in the projecting sides of the truck frame, and bearing down on the handle lifted the barrels clear of the ground. I need hardly remark that the dock was white-washed and carbolized after every dumping. I am at a loss to suggest a suitable means of disposing of the liquid garbage of a field camp, although something might be effected by pouring the fluid through several screens of decreasing mesh, roughly filtering it. The residuum would go in the solid garbage pile and the filtrate might be poured into a large hole dug several feet deep in gravel or sand, filled in with large stones, carbolized and kept covered.

At the outset, the food was cooked for the men as already stated on Boosicott field ovens and their meals were served on mess tables brought over from the receiving ship. The men themselves were seated upon the ordinary mess benches. Almost immediately there was begun the erection of a mess hall which, when completed, was 600 feet long by 26 feet wide, a simple structure with numerous windows and exits, and built near the permanent galley. The men experienced a profound sense of relief when they were able to move the mess tables and benches under cover and escape the annoyance of flies and the various vicissitudes of the weather, finding shelter under a rain-proof roof, and within a capacious room from which the too energetic mosquito and other insects were excluded by wire screens. You cannot fight the myriad of winged pests but you can keep them at bay by screens which are only opened, as in the

case of a door, when something or somebody is actually passing through. Unless screens are kept closed they are a delusion and a snare.

Before we part company with this interesting pest, I may say that the men were protected at night from mosquitoes by means of netting 18 feet square, hung up inside of the tents by stops or *tie-ties* which ran around the inside of the tent at the height of the vertical wall.

In the morning these nets were made up tightly and secured by the same stops on one side of the tent. This was part of the early camp routine, all bedding being rolled up neatly, placed at the edge of the wooden platform 14 ft. x 14 ft. built by Construction and Repair under each tent, and the tent flies thrown back so as to permit free sweep to the winds that blew through the camp.

For scrubbing and washing clothes, a number of rough tables, about waist high, were erected along the north bank of the island inclined away from the user so that the water and suds would run down the bank into the back channel. It will be noted that the drainage of the camp, as well as the latrines, was on the Delaware River side of the island. Thus it was impossible for any waste of the camp to foul the men's clothes. As the water in the back channel, while very fresh and soft, contained a largish amount of sediment in suspension, a number of empty water tanks, which had been landed from ships put out of commission, were taken over to the washing place and a handy-billy rigged to deliver water into them. These tanks being filled every night, the water in the morning was quite clear. Posts were set up and clothes lines stretched in the immediate neighborhood of the washing tables. Whenever the camp became at all crowded, the different divisions into which its inmates were organized took turns at the tables. There being so many recruits concerning whose previous history nothing could be known, it was not unnatural that a certain amount of thieving should have occurred. To minimize this annoying practice, certain precautions were taken, which are described in the following:

Special Order No. 3.

CLOTHES.

"Men will be allowed at all times to hang clothes on the lines to dry, but clothes can only be taken from lines at 2.50 p. m., when all hands will be

called to stand by wash clothes. The officer of the day will in person superintend this evolution; he will be aided in this by the Masters-at-Arms and the Marine Non-commissioned Officers each of whom will be assigned to a section of the clothes lines. Every piece taken off the lines will be examined by a non-commissioned or petty officer to identify ownership. Unmarked clothes will be put in the "Lucky Bag." The lines will be cleared each day of all excepting wet clothes and all unclaimed clothes will be taken in charge of by the Master-at-Arms and must be called for by the owners within 48 hours; after that time these clothes will be taken to the "Lucky Bag." All wet clothes will be moved to the western end of the line and will not be taken off until the next day at "Pipe Down Clothes."

The pressure became so great that the general permission of the first paragraph of this order had to be withdrawn, and

Special Order No. 3 was modified as follows:

"The divisions commanded by Lieuts. Long, Blakely and Murfin will scrub clothes, on Monday, Wednesday and Friday.

The divisions commanded by Lieuts. Rowen and Pearson, will scrub clothes on Tuesday, Thursday and Saturday, during the morning drill period.

The officers in charge will march the proper divisions to the wash boards immediately after muster at 9.15 o'clock.

Men having no clothes to wash will be turned over to the different police parties for work.

The other divisions will carry out the regular routine.

At 2.50 p. m., wash clothes will be piped down, when the divisions that scrubbed clothes during the morning will be marched to the lines for their clothes.

At no other times are men allowed in the vicinity of the lines or boards.

All unclaimed or unmarked clothing will be taken in charge by the Master-at-Arms, the unmarked to go immediately to the lucky bag, the unclaimed to be kept for 48 hours, if not called for then to go into the bag.

As indicating a curious form of abuse, I also quote Special Order No. 2:

"1. The water in the iron tanks at the wash boards is to be dipped out in buckets and no man is permitted to wash his clothes in the tanks."

Special Order No. 13.

The Divisions washing clothes will have the privileges of the barber shop for that day. No man from another division will be allowed this privilege without special permission from the officer of the day.

Bathing was permitted, by divisions, at appointed times in the Delaware River, care being taken that the bathing place was above the drains and latrines with reference to the tide; to the east in case of ebb tide, to the west when the tide ran flood.

There being no fire apparatus close at hand, it became necessary to provide for such instant action as might be possible, pending the arrival of fire engines from the Navy Yard. What was to be done is shown in the next general order. There being always an abundance of tools handy, and the camp being located on sand, it would have been possible to smother any fire which originated, and remained, close to the ground.

Special Order No. 4.

FIRE REGULATIONS.

"1. In case of fire in the camp all the divisions will fall in the respective streets, and await orders from the officer of the day.

2. The divisions in whose street the fire occurs will break all the tents to leeward of the fire immediately upon its discovery.

3. The burning tents are to be broken, and the fire stamped out."

Almost the first consideration on the part of an officer establishing a camp is to secure immediately a large number of tools, such as, spades, shovels, pick-axes, mattocks, hook-ropes, rakes, hoes, scythes, brush-scythes, etc. In some localities, it will be desirable to have one or more small, but stout, tripod shears, with a purchase and straps, for lifting bolders out of the ground; the latter may be landed on rough drags, made out of stout boards, and hauled either by hand or by animals, to a suitable dumping ground. Above all things, have an abundance of rakes so that there need be no excuse on the part of any division for a street littered up, or in disorder. The rake is to the camp, as the comb is to the man's head. When the latter is frequently used, we speak of the man as well kempt. The camp should, similarly, always be well kempt. At first, we kept our tools in a tent assigned for that purpose, but later, when the camp gave promise of being more or less permanent in character, a small-tool-house was put up which proved extremely useful in many ways. It is hardly necessary to suggest that a suitable means of issuing and receiving tools, and a strict system of accountability for them, should be inaugurated.

Among the other buildings, which were started at once, were, first, a small frame affair, as ship's and recruiting office, armory and marine's office and store-room. In a second, adjoining building, of about the same size, were the pay office and the paymaster's storeroom. These two were erected near the tent of

VIEW OF THE CAMP FROM THE SOUTH. THE NEAREST TENT IS THAT OF THE COMMANDING OFFICER. ON THE RIGHT ARE THE OFFICERS. THE ROOF OF THE MESS HALL SHOWS IN THE DISTANCE.

the commanding officer, between which, and the officer of the day's tent, was a flag staff carrying the national colors. In the rear of the camp, and to the right, that is to say, at its north-east corner, two more small buildings were placed, one containing the surgeon's office and examining room—being for that purpose made rather over 20 feet in length—and the medical dispensary. At the other extremity of the camp, namely, at its northwestern corner, were two prison houses, one, a large general brig, the other a prison proper with twenty cells. To secure ventilation, both of these buildings were made with slatted sides, stout wire gauze preventing any passing of forbidden articles to the prisoners within, thinner wire gauze being used to keep out mosquitoes and flies. So ample an accommodation was required because, as the service well knows, receiving ships are the places where men are delivered by the police apprehending them, for desertion, absence without leave, and other offenses, and where they are retained until their cases are disposed of, either by restoration to duty, or by confinement, following the action of a court martial, either general or summary. With the exception of the men in solitary confinement, the prisoners were very largely used for policing the rear of the camp, and in so doing they got exercise and health, while rendering valuable service in return. Those undergoing punishment in double irons had their hand-irons taken off during working hours. I may say that it was regarded by a prisoner as a great hardship not to be allowed to have his trick in the working gang. Near the galley a storehouse was erected for provisions. It was fitted with a refrigerator room where delicate meats and other perishable articles could be kept at a proper temperature. It became necessary to pay very strict attention to the cleanliness and order of this storehouse, inasmuch as a little sugar, for example, spilled on the floor, or some pieces of broken ship's biscuit, would be known instantly to all the flies within a radius of miles. But this trouble was very soon remedied and ceased to occupy our attention.

We had the use of a suitable room in the navy yard, not far from the entrance to the camp, for the combined purpose of the "Lucky Bag," and as a room for the bags and hammocks of men absent on leave, or otherwise. Between the lines of the following orders it will be possible to read the existence of a certain

amount of previous irregularity or carelessness. I have every reason to believe that no complaints were made subsequent to the issue of Special Orders Nos. 9 and 12.

Special Order No. 9.

"All registered mail must be delivered to the *Person* to whom addressed in the presence of THE OFFICER OF THE DAY."

Special Order No. 12.

"The effects of men arriving at or departing from the camp will be disposed of in the following manner:

1st. When men are transferred to this station, from another ship, or station, and their bags and hammocks are sent in advance of them, a list of the numbers of these bags and hammocks will be taken by the Chief Master-at-Arms in the presence of the Officer-of-the-Day; the Master-at-Arms will then receipt a copy of this list and give it to the Officer-of-the-Day, who will O. K. it and turn it into the office of the Executive Officer.

2nd. When a recruit is received at this station and fitted out, an assistant to the Chief Master-at-Arms will take charge of his civilian clothing, and will ask the recruit whether he wants the clothes sent to his home or burned up; if they are to be sent away the Master-at-Arms will give him a receipt for them and then see that they are expressed, retaining the express receipt; if they are not to be sent away, they must be burned at once.

3rd. Men going on leave, or men who are to be absent for any other reason for more than forty-eight hours, or men to be placed in the brig will turn their effects over to the Chief Master-at-Arms, who will check each piece separately and give the owner a duplicate check. Such effects can then be claimed only by presenting the duplicate check.

4th. Bags and hammocks sent from the hospital will be taken charge of the same as in case 1.

5th. The effects of men who are absent over leave, or who are absent without leave, will be taken charge of the same as in case 1. If these men are declared deserters their effects will be turned over to the Paymaster for sale. Each morning the Executive Officer's writer will hand to the Chief Master-at-Arms a list of the new absentees in order that he may secure their effects."

I would earnestly suggest to any officer about to establish a camp to be very particular upon a point which needs no further mention than citation of:

General Order No. 2.

"The attention of men in camp is called to parasitical vermin. It should be remembered that to get vermin upon the person is a misfortune, an accident which might happen to anyone. In this there is no humiliation whatever. But it would be an unpardonable offence, if any man, from a false sense of shame, should conceal the fact of his being lousy (for

example) and thus pass the trouble on to his mess mates. For the sake of all concerned, you are earnestly requested and positively directed to report these cases to the officer commanding your division whether happening to you or to some other person who fails to report himself."

At first we used for lighting, the ordinary kerosene lantern, but very shortly conductors were run down from the yard system and the permanent installation effected of electric lights—incandescent in the offices, and arc lights about the grounds.

There can be no doubt that the men vastly enjoyed the change from the overcrowded receiving ship to the spacious and airy camp. Life became and remained a form of picnic—although the hours of work were longer than before and the hours of drill no shorter—still the sunlight, the cool breezes, the contact with mother earth made everything attractive, and the men thrived like young plants; they "waxed and grew fat."

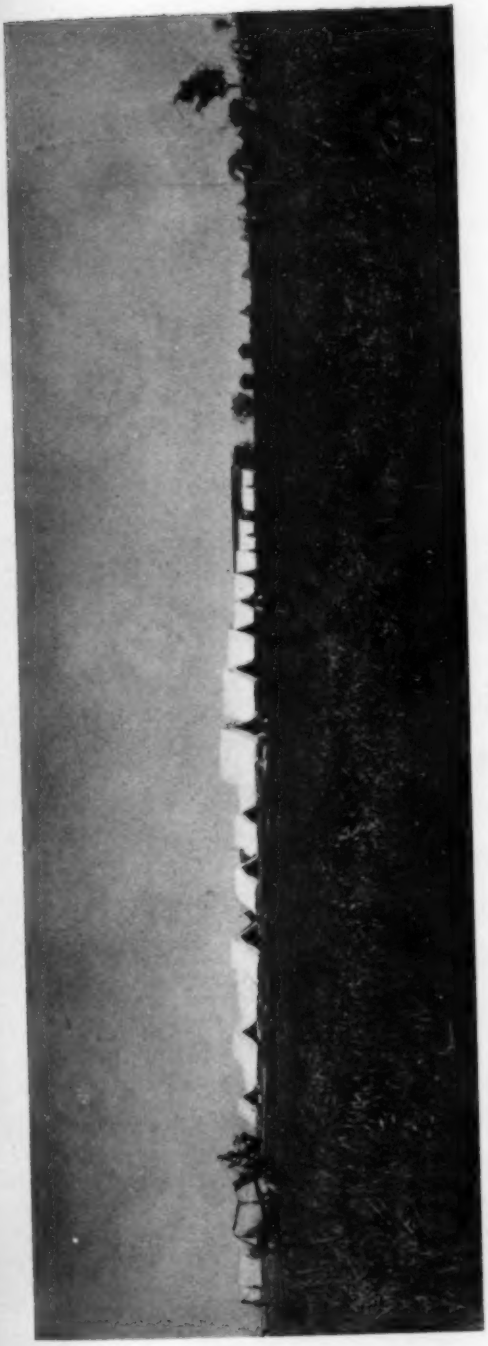
Sports there were of every variety, base-ball, quoits, track athletics, etc., etc., while bathing was more than a pleasure. Indeed it became a temptation to resist which the extraneous help of an argus-eyed patrol was necessary, for unauthorized swimming was not only bad as a breach of discipline but it was fraught with danger from drowning or from infection as elsewhere noted.

The wants of the men in one essential were specially supplied and on a scale novel to my experience. Surgeon Biddle interested himself so much in this matter that it was impossible to deny him, even had I been moved to do so. A tent was set apart near the dispensary and a competent dentist engaged who brought down his chair and engine and all the other instruments of torture which a diabolical ingenuity has devised. His victims were like the sands of the sea, but happily surviving, they left the camp and went into the service every man jack of them sound in teeth. It goes without saying that a special schedule of prices was agreed upon by which the men secured first class work at the lowest possible rates, and the dentist got lots of valuable experience.

The rules of the camp as to the visiting in each other's tents were as strict as those of the Naval Academy during study hours. But—and this is an important distinction—they were laid down by the men themselves and they were enforced with a brutal firmness and a thoroughness which the officer may envy but may not emulate. It proved a wise precaution, and reduced pilfering to an almost insignificant amount.

I have described, in a general way, the machinery as it gradually took shape. I have now to enter upon the extremely important one of how this machinery was operated in order to secure the results for which it was created, namely, the stamping out of the three classes of contagious disease to which reference was made in the beginning of this article. The general scheme was based upon the assumption that three weeks of isolation and of immunity from disease would give the men a clean bill of health;* therefore, the camp was divided into three parts, whose sizes varied from time to time according to the necessities of the occasion. The eastern third formed a camp of reception; the middle third, a camp of observation; and the western third was known as the clean camp. At the northeastern corner was, as has already been stated, the surgeon's office and dispensary, beyond which were more or less tents for "suspects," for sick or for men known to be suffering from contagious disease. It will be observed that, taking the prevailing wind into account, the "suspects" were to leeward, next came the men freshly received, then those under observation, while to windward were those presumably sanitarily clean. No matter from what source he came, every man went at first into the camp of reception and there spent a week; if healthy at the end of that time, he advanced into the camp of observation, but if he developed any suspicious symptoms he was sent into the camp of "suspects" under the eye of the surgeon, and when pronounced cured he went back into the camp of reception and began his three weeks over again. It was strictly forbidden for men to associate, at any time, or for any purpose with men of another division. In this way the men in the different camps were as much isolated as if they had been living on different islands. Officers and petty officers in charge were directed to examine carefully at morning and evening quarters the appearance of every man and to send at once to the surgeon any who seemed in the least drooping. No matter in what part of the camp it occurred, the outbreak of any infectious disorder involved sending the man himself, and all his tent mates

*Our estimate of the period necessary to prove the absence of contagion has received the stamp of official approval. The Bureau of Medicine and Surgery has issued instructions providing that all recruits coming to the League Island Navy Yard must pass twenty-one days under sanitary observation in the detention barracks before being assigned to a division.



VIEW FROM THE SOUTHEAST.

at once to the camp of "suspects." The mess gear of each division was kept by itself, and in case of disease, the mess gear used by the man, and of his tent mates, was immediately condemned to be sent with them to the "suspect" camp. All the mess gear used in this "suspect" camp was aseptically cleaned under the supervision of the surgeon.

I had personally, from the first, felt that a very convenient medium for the spread of disease lay in the use of mess gear in common. I was therefore, gratified to receive a recommendation from Surgeon Stokes, who visited the camp on the part of the Bureau of Medicine and Surgery, to confer with Surgeon Biddle, that the water cup at the scuttle butt should be kept habitually in a weak solution of formaline. Every man using the cup must return it to the bucket containing formaline. A marine sentry with strict orders and no discretion carried out this injunction. This powerful disinfectant is colorless, tasteless when diluted by 100 parts of water, and yet strong enough in its action to kill all microbes. After the adoption of this precaution, mumps began to disappear and measles followed suit. I do not wish to be understood as attributing to this one measure more than its proper share in the general result, but I think the use of formaline in this manner should be encouraged throughout the service, as I am informed that it has elsewhere proved, and especially on board ship, a most useful device for preventing the spread of disease through the general use of the the same drinking cup.

It was with fear and trembling that we approached the end of the first three weeks of camp life, and we rejoiced and welcomed the day when we could pronounce two divisions of landsmen for training absolutely free from infectious diseases, and, therefore, available for transfer to the Yankee, then lying at the yard. While the men themselves were strong and healthy, in excellent trim, their cheeks bronzed by exposure to the sun and air, and their muscles hardened by drills, exercises and sports, and the health-giving labor of clearing so many acres of ground, it was essential to the complete success of the scheme that they should not carry concealed about their persons, or in their belongings any trace of contagion, or any live microbe. It was necessary, therefore, to cleanse the one and to disinfect the other. As this was likely to be a constantly recurring operation, I thought it better to place

the whole matter in the able hands of the surgeon so far as the medical part was concerned, and of one lieutenant for the military part. I have every reason to congratulate myself upon the wisdom of my selection, for Surgeon Biddle was most painstaking and thorough in all that he undertook, not only in this connection but all during our camp life, while Lieutenant H. A. Pearson managed the men with great skill and tact. The method adopted was to utilize the after berth-deck of the Puritan for the purposes of disinfecting bags, hammocks and personal effects. Clothes lines were strung between the beams so that this compartment became a vast drying room and three large formaldehyde lamps employed.

It will be convenient to follow one division through the whole operation. After turning out, the men marched from the camp, with bags and hammocks, to the receiving ship. Below in the disinfecting compartment they opened bags and hammocks and hung all their belongings upon the lines. They were encouraged to leave their shoes and stockings behind them. On coming up they were extremely lightly attired. The lamps being started to generate the gas, the disinfecting compartment was tightly closed for about three hours, which time was spent by the men in breakfasting and in exercising in boats. When their clothes were considered to be sufficiently disinfected, or approaching the close of their disinfection, the men were marched on board the Puritan again and behind screens enclosing quite a piece of the upper deck. Here they were made to strip naked and to leave their clothes on the deck. (These clothes, by the way, were disinfected with the next batch of men, and when so disinfected were returned to their owners.) On entering the bathing place each man was handed a piece of soap. The hose was turned on the men and they were wet down thoroughly. The water being quite cool and under a heavy pressure, the immediate result was to produce a tremendous volume of shrieks and yells, but the effect was most salutary. The men were charged to soap themselves thoroughly from head to foot, and especially to shampoo their hair, in which microbes might possibly lurk. At the conclusion of the washing, towels were furnished by the medical department, and these were afterwards disinfected. The disinfecting compartment would now be opened, and the men would go down below, still *in puris naturalibus* and get their clothing,

bring it on deck, dress themselves in clean and disinfected attire, form and march on board the Yankee. The best method of adopting this fumigation was worked out by Surgeon Biddle and Lieutenant Pearson by experiment with some 600 men who went to the Yankee. After that, the drafts being very much smaller in number, the whole matter was placed in charge of the medical officer who was assisted by the officer of the deck of the Puritan, and such petty officers as the officer of the day saw fit to detail.

I had hoped that the medical aspects of our unusual experience would be presented to the service by Surgeon Biddle in not too technical form, but, for reasons sufficient to him (doubtless a reluctance to sound his own praises and to claim the professional credit of an exceptional familiarity with a rare and very obscure disease) he prefers to observe a silence as modest as it is regrettable.

It is gratifying to know that our methods have endured, their results justifying the erection of three frame buildings (barracks) and the establishing of the camp on a permanent footing.

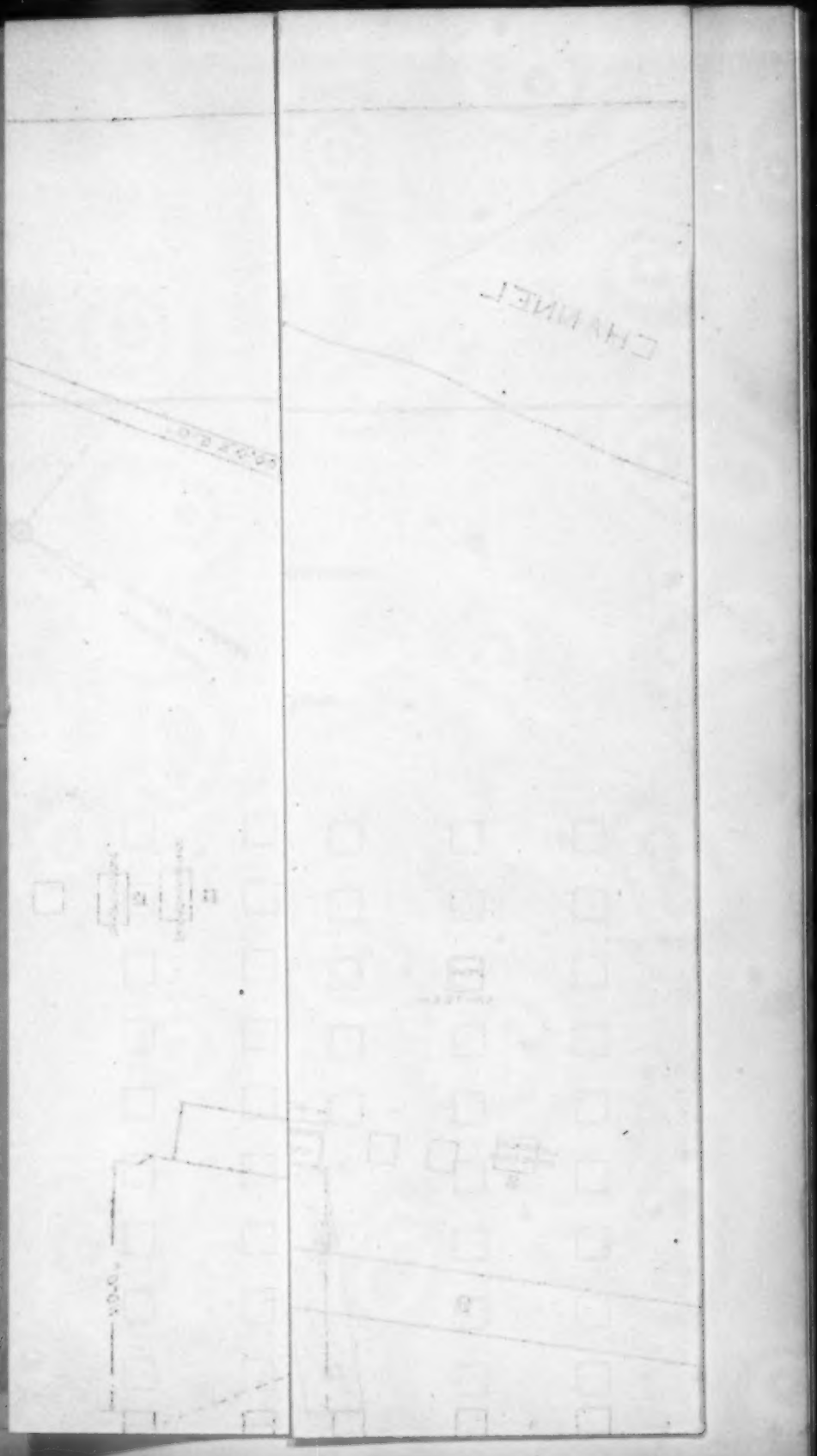
And yet, I think an important precaution remains to be taken, one which I have long advocated. There seems to me no better place than this to urge the erecting at every large navy yard, especially at those near great centres of population, of a modern up-to-date disinfecting plant containing, with other appliances, steam heated retorts for bags, hammocks, bedding and personal effects of officers and men and formaldehyde generators for their appropriate uses. Periodically on visiting a navy yard, a ship, her personnel and their belongings should be thoroughly disinfected. The mere financial economy which will flow from this scientific prevention of disease through reducing the sick list to a vanishing point, thus swelling our effective numbers, and the utter abolishing of epidemics will abundantly warrant the initial expenditure.

Our progress at League Island through the valley of disease to the upland plains of health was not devoid of long and painful halts or even of going a second time over certain parts of the journey. Time and again we flattered ourselves that we had gotten rid of all contagion only to have a case of mumps, or measles, or spotted fever break out and plunge us into fresh despair; but we persevered, abating none of our precautions,

until by the end of June we could look back over a clean record of a fortnight, and flatter ourselves that the hard fight was won.

Surgeon Biddle's records show that, the camp having been pitched on May 20th, the last case of mumps occurred within three weeks or on June 8th; the last case of measles on June 16th. About July 1st we felt confident that spotted fever was likewise, a thing of the past, but on August 15th, a patient returned from the Naval Hospital, reported as cured from a former attack, developed a relapse. Strictly speaking, therefore, we can only assert that on St. Napoleon's Day, cerebro-spinal meningitis took its final departure completely vanquished and that in quitting us it placed the crown of victory on our weary labors.

Although the story is ended, I can not leave the subject without expressing the hope that Captain Charles M. Thomas, U. S. Navy, may be induced to round out my account by contributing, either as a separate essay or as a discussion of this paper, the many additional devices, rules, precautions and methods which he adopted at Norfolk towards the same end or which differed from those I have described for the reason largely that, although equally earnest, no two persons look at the same question in exactly the same way. With his larger task, his wider experience and his well known success he is in a position to add to this article much which is lacking and thus lay his brother officers under new obligations. If through what I have written, Captain Thomas can be tempted to complete our knowledge of how such a work should be planned and executed, the service will, I am sure, agree with me in holding that I have not written in vain.



BACK CHANNEL

STATION "C"

CANTEEN

CHAPLAIN'S STORE HOUSE

8

PAYMASTERS STOREHOUSE

6

COOK HOUSE

7

300'0"

9

4 GUARD HOUSE

43'0"

3 PRISON

75'0"

MASTER-AT-ARMS

TOOL HOUSE

5

MASTER-AT-ARMS MESS TENT

55'0"

13 BARRACKS

14 BARRACKS

55'0"

80'0"

50'0"

OFFICER of DAY

FLAG POLE

EXECUTIVE OFFICER

STATION "A"

E. M. Mattern
WM. L. PETTIT

WASH TABLE 500'-0" X 5'-0"

MAIN BOILER HOUSE

10

11 SURGEONS OFFICE

12 DISPENSARY

HOSPITAL TENTS

STATION "B"

BOILER HOUSE

65'-0"

COOK HOUSE

7

MESS HALL 600'-0" X 26'-0"

110'-0"

14 BARRACKS

15 BARRACKS

8" DIA. DRAIN PIPE

50'-0"

OFFICER of DAY

186'-0"

ARMORY

SHIPS OFFICE

RECREATION OFFICE

MARINE BARRACKS OFFICE

PAY OFFICE

CLOTHING ROOM

2

1

TRUE NORTH

COMPASS NORTH

BUILDING No 1

2
3
4
5
6
7
8
9
10
11
12
13
14
15

STATION "B"

WASH TABLE 500'-0" X 5'-0"

Main Boiler House

10

11 Surgeons Office

12 Dispensary

HOSPITAL TENTS

STAT

Boiler House

65'-0"

COOK HOUSE

7

MESS HALL 600'-0" X 26'-0"

110'-0"

14

BARRACKS

15

BARRACKS

8" DIA. DRAIN PIPE

BUILDING No 1

" 2
" 3
" 4
" 5
" 6
" 7
" 8
" 9
" 10
" 11
" 12
" 13
" 14
" 15

TRUE NORTH
COMPASS NORTH

STATION 'B'

2

1

STATION "D"

WASH TABLE FOR DISHES 100'0"

RIVER

DELAWARE

CAMP FOR OFFICERS AND CREW

U.S.S. MINNEAPOLIS

SCALE 3 INCHES = 100 FEET.

NAVY YARD LEAGUE ISLAND, PA.

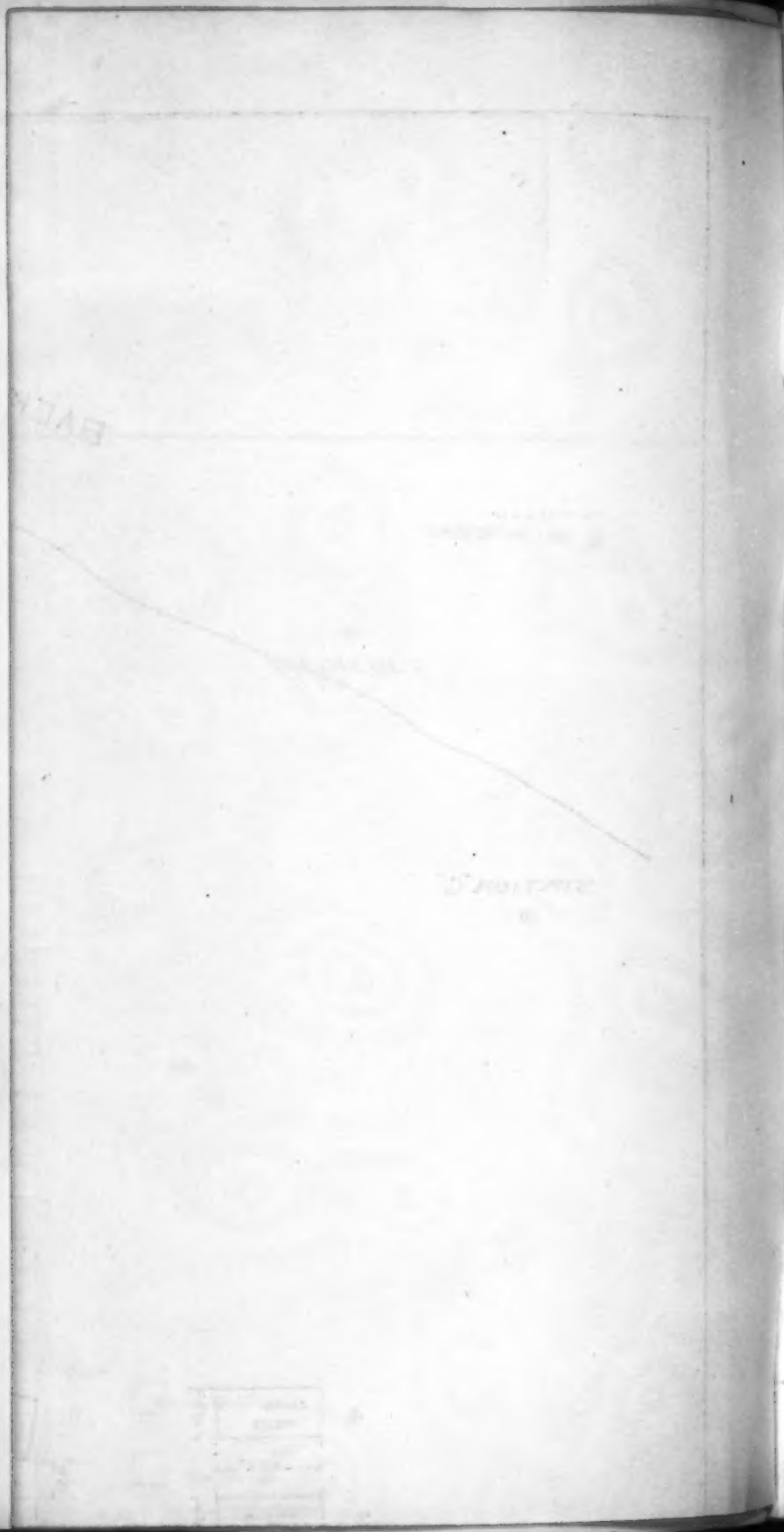
JUNE 1905

Lloyd Gibbons

NAVAL CONSTRUCTOR U.S.N.

6-10-03
9-26-03

25-D-94



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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SKELETON MODELS OF MODERN SHIPS.

By COMMANDER W. H. BEEHLER, U. S. N.

The costly, complicated, naval constructions of the present age are such intricate structures that the ordinary drawings are exceedingly difficult for the practical seaman to comprehend, and models that will show all details of the interior economy are necessary for the personnel on board to handle and fight a modern battleship most efficiently.

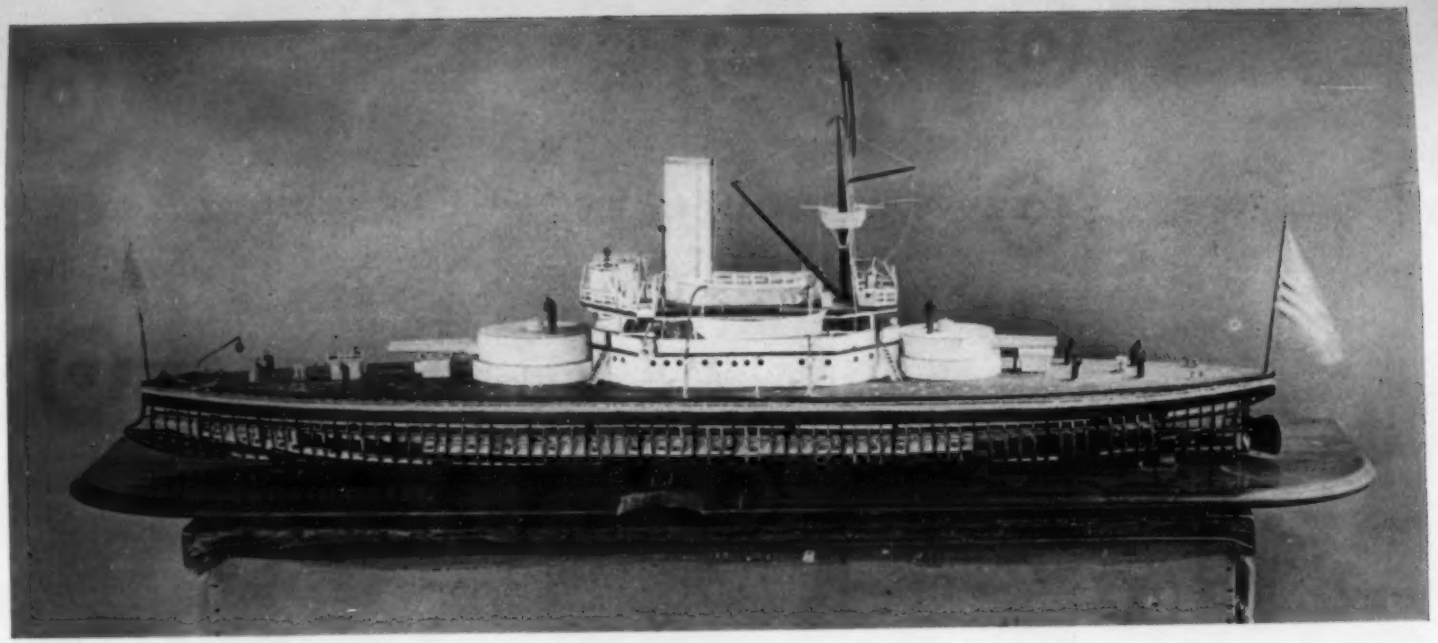
This necessity has long been recognized by the German navy, which being untrammeled by old traditions is less conservative and in many respects more progressive than are the navies of other powers. All modern German warships, both battleships and cruisers, are furnished with skeleton models for the instruction of the personnel on board. They recognize the fact that it is of great importance for all on board to thoroughly know every feature of the construction and equipment of their ships. In the United States Navy the need of these models has been felt but not met as yet, chiefly because other features of naval progress have preempted the claims of these models. Our officers have diligently studied the development of modern warship construction with its complicated system of watertight compartments, and feel that they do not need these skeleton models as much as do officers of other navies who are not so highly educated. But a little reflection will convince all that nothing should be omitted to insure a thorough knowledge on the part of the officers and men of their own ship.

The drawings and blue prints that are furnished in the outfit of all vessels are technical productions, which cannot be readily understood by the men and which require even for officers con-

siderable time to study. These plans are usually kept by the captain, executive and officer in charge of Department of Steam Engineering. There is no draughting room on board, and some of the drawings are so large and inconvenient to handle on board that they cannot be conveniently studied. One is almost invariably obliged to go below into the compartment in question to get a correct idea of the situation, the relative space occupied by pipes, valves, etc., in a compartment and its relation to neighboring compartments, etc. Detail drawings generally fail to show the environment of valves, etc., and inspection of the drawings is rarely satisfactory. Even after going below into store rooms the watertight bulkheads prevent direct access there to neighboring compartments, and an exact idea of surroundings cannot readily be obtained even by personal inspection unless one devotes a great deal of time and care to study those features. This is what must be done by those who are specially detailed to carry out the regulations for the care and preservation of our ships, the executive, hull board, etc., but for the other officers and men skeleton models are necessary for them to know the ship thoroughly.

Having seen the skeleton models on board vessels of the German navy, the writer called atention to them while naval attaché and explained the use which the German navy made of these models for instructing the officers and men about the ships in which they were serving. These skeleton models are made of tin and usually on a scale of one quarter of an inch to a foot; they cost, according to the size of the ship, from 2000 to 10,000 marks, $500.00 to $2500.00, and this money is well invested, by an economical administration.

In reply to my reports I was informed that the Bureau of Construction intended to construct models of typical U. S. Battleships for the use of the Naval Academy, but upon further consideration it was found that they would be so expensive that they could not well be undertaken without special appropriation. The skeleton model of a ship like the " Alabama " woud cost nearly $5000.00, at which rate the construction of models of 20 battleships would amount to $100,000.00. The Bureau was anxious to have such models but did not have the money to construct them. But even this sum and ten times that amount would, in the writer's opinion, be much more wisely expended for skeleton models than for the ornate models that have been made of all our ships for exhibition



VIEW 1.

in the great expositions at Chicago, Paris, St. Louis, etc., and which only show the exterior appearance of the ships without giving any view of the interior details. These expensive toys only show what can be equally well seen in photographs and which being exterior becomes thoroughly familiar to the crew in a few days after joining the ship. They are of but little value to train the officers and men to handle and fight the ship most efficiently; and yet these expensive toys cost quite as much as the estimated cost of a very complete skeleton model that would at a glance convey a satisfactory idea of the entire interior economy and fittings which would enable the crew to manage the ship much better than without the knowledge such a model would give.

Upon his return from duty as naval attaché at Berlin, Vienna and Rome, the writer was ordered to the Asiatic Station and took command of the U. S. S. Monterey at Canton, China. Shortly after taking command he proceeded with the Monterey to Hong Kong, where upon inquiry he soon found a Chinese carpenter whom he engaged to construct a model of the Monterey out of wires, paper, and wood. This Chinaman had two assistants who, by taking the blue prints, constructed a complete working skeleton model on the same scale as the plans, one quarter of an inch to a foot. They did all the work on board as the plans were not allowed to leave the ship. They simply bent a large wire to represent the keel and stem and stern posts, after that they bent wires to shapes according to the plans of each and every frame and secured these wires representing the frames to the keel wire and attached the longitudinals in their proper positions. These wires formed the skeleton of the ship. A narrow batten was then secured inside to represent the keelson of a width corresponding to the scale of the depth of the double bottom. The inner bottom was made of card board in sections of the interior watertight compartments. The outer skin plating was left off and the spaces along frames were filled in the double-bottom with card board representing the bulkheads of the double-bottom compartments. In this manner all the details of the interior of the ship were made of card board glued in and all exactly to scale.

Wires painted red, green, gray, etc., as adopted in the service, were used in proper places to show the piping, fire mains, drainage system, in the double-bottoms, etc., ventilating pipes, etc. All the water-tight bulkheads are painted black and all details of the

drainage and ventilation of the different compartments and means of access are clearly indicated.

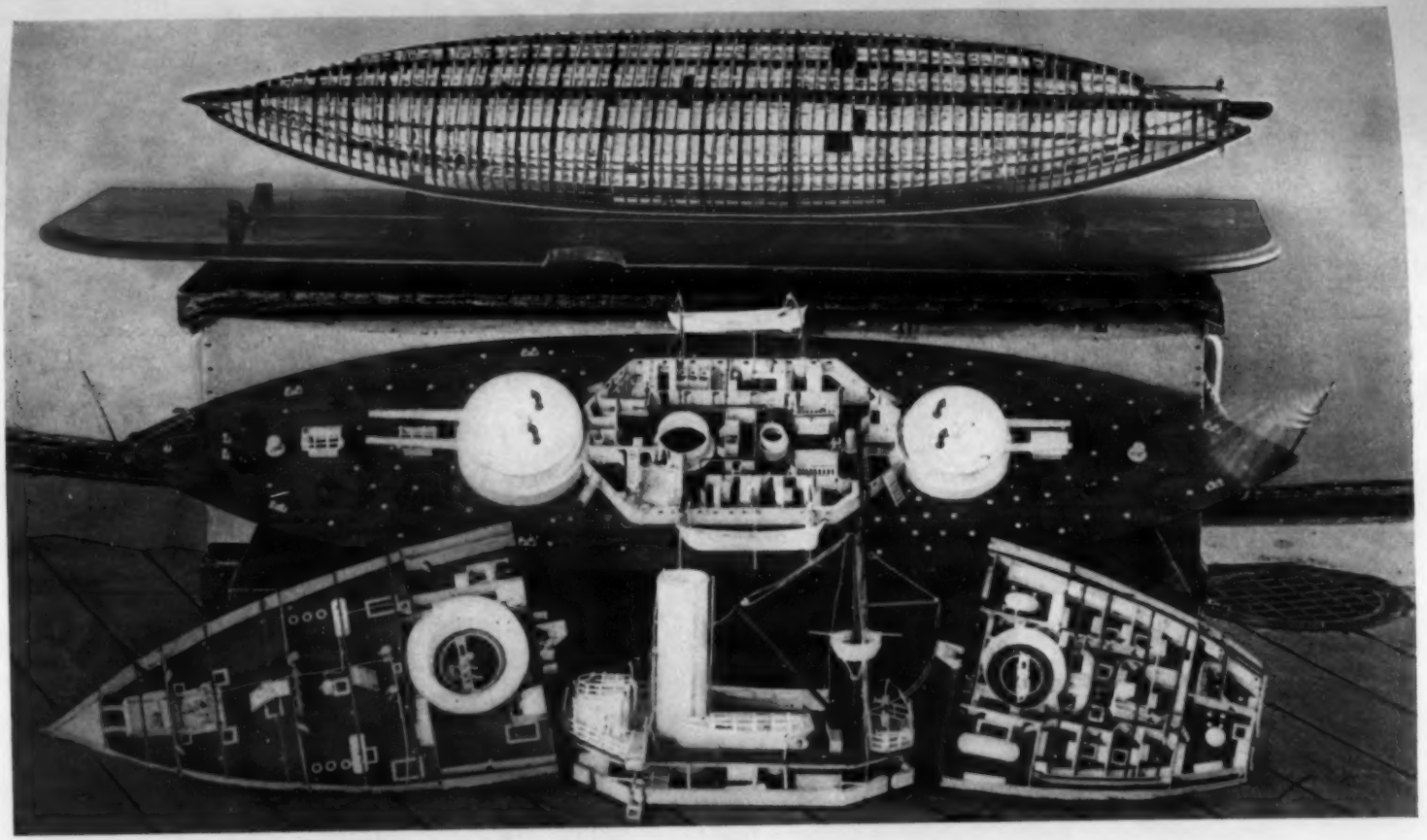
The accompanying illustrations taken from photographs of the model convey a good idea of the scheme as carried out.

The first is a side elevation of the model when assembled. All the essential characteristics of the ship that are given by the expensive exhibition models are hereby shown; besides the side view of the double-bottom, the depth and extent of the armor belt and the structural support given by the numerous compartment bulkheads constituting the cellular system of naval construction.

In the second view the model is represented as taken apart to show the interior details. The upper part of this shows the holds, etc., with upper decks removed. The watertight compartments of the holds to the left, showing under the forward berth deck all the arrangements of the store rooms, magazines, etc., next the coal bunkers that envelope the fire rooms and engine rooms. The six boilers, four Ward and two Scotch boilers, are seen in their positions with their uptake connections to the smoke pipe, also pipes that lead to these boilers and to emergency valves in wing passages and above to within the superstructure. The engines are not represented in the model since on such a small scale the intricate details could not be so well represented and for the practical uses of this kind of a model it was not necessary to go to such details. In fact other minor details, such as the hand railing around the deck, awning stanchions, some boat davits, etc., are likewise omitted as not being essential to represent; though in the exhibition toy models such details are made as accurately as is goldsmiths' work. In a naval engagement such details would all have to be cleared away and skeleton models are for practical instruction to enable the personnel to fight the ship most efficiently. Further to the right the store rooms, shaft alleys, magazines, etc., under the after berth deck, are seen, and abaft that the steering engine compartment is seen; this last steering engine compartment also lifts out and shows the trimming tanks beneath.

In the middle part of the view there is the Monterey's spar deck with the superstructure deck removed. Here are seen the arrangement of the rooms, the galley, armory, machine shop, offices, etc.,

In the foreground there are three sections, the first being the



VIEW 2.

forward berth deck with handling room platform deck. In the center there is the upper part of the superstructure with the two bridges, masts, and smokepipe. To the right the after berth deck, officers' quarters, ward room, and cabin.

The third illustration shows very much the same as the second, except that the upper view represents the ship upside down, reversing the top view of the second illustration. This shows the double compartments, sea valves, and the drainage system both main and secondary drains being represented by wires.

A characteristic experience which the writer had while constructing the model is of interest. About the end of May, 1903, just before the Monterey was to sail for Chefoo from Hong Kong, it was most desirable to finish the model before sailing, and the writer told the Chinese carpenter that he wished him to represent the small pipes and valves that connect the secondary and main drains in the double-bottoms under each section, so that he could show how the double-bottom compartments can be drained and pumped out. He suggested that this could be done very quickly (being pressed for time to finish) by using putty, which might be rolled into small cylinders about one-half inch long and one-eighth of an inch in diameter and simply pressed in at the locations of these valves in the double-bottom compartments. The Chinaman stared blankly as if the suggestion was utterly incomprehensible, he left the cabin and I supposed that feature would have to be omitted. He however returned soon after with a bunch of small maccaroni that he had obtained in the galley and taking a pair of scissors he began to cut the pieces of maccaroni into small bits of the requisite size to show the drainage valves and then glued them in saying, "this belong more ploper, putty dly up and fall out."

These illustrations do not convey an adequate idea of the skeleton model of the Monterey, the piping is not so clearly shown in the views and one only sees that the model can be taken apart and that it contains the arrangement of rooms and compartments.

In reply to my report on having made this model at my own expense the Bureau of Construction authorized its purchase on an open purchase requisition, so that the amount which I had paid, $110.00 gold, was refunded to me. It took the three Chinese carpenters three months to make this model, though at times only

one man was employed at work on it. The model was completed in about 60 working days for one man, as they often failed to work for days, and then all three would be diligently at work again. These men had never made such a model before and they at first estimated that they could do the work for $150.00 Mexican, which at the then rate of exchange would have amounted to about $58.00 gold, but after they had done as much work as they were willing to do for the first estimate I had to encourage them from time to time to proceed with more details by offering $20.00 now and then until the total cost as it is amounted to $110.00 gold. This is so ridiculously cheap for such a fine model exactly to scale and showing all that is practically necessary that those who have seen the model invariably expressed their surprise that it cost so little. It is very strong and has been handled by the crew without being injured, and after having been painted it is more durable than prints.

Although Chinese labor is so much cheaper than any other, yet I am confident that I could arrange to have constructed in Baltimore similar models of all our ships at a cost of about $250.00 for a vessel of 4000 tons like the Monterey and for similar amounts according to tonnage not exceeding $1000.00 for even the largest battleships. Of course these models would not have any of the beautiful goldsmith work as is used to make hand rails, boat davits, etc., in the expensive exhibition models such as we now have.

Such models should be kept on board of the ship of which they should serve as supplementary plans, as did that of the Monterey. An example of its use will be understood by the fact that when the board appointed by the commander-in-chief of the Asiatic fleet had to consider the question as to a change in the type of the boilers that would be suitable to replace the Ward boilers, they found the model showing the space in the two fire-rooms a valuable guide for them in recommending a suitable type of boiler that would fit. Exact dimensions were of course given, but the model gave solution at a glance and was tangible evidence much better than any other.

Objections have been raised that such models would reveal the vital features of a ship and an enemy or a possible enemy might get valuable knowledge of the plans of our ships from seeing such a skeleton model. The reply to this objection is conclusive

VIEW 3.

from the fact that detailed copies of the specifications of all our ships are published and sent abroad to foreign admiralties so that those most interested in knowing the plans of our ships have much more details of them than they could obtain from a skeleton model. The Germans make no such secret of their models and the writer had no difficulty in seeing and closely examining those models of German ships that he inspected. The contractors who have built our ships are furnished with detailed plans and specifications. The skeleton models do not show gun mounts, etc., that might be considered as confidential secrets, but it would be impossible to keep secret such details as are shown by these models and which are most valuable for instructing the personnel about their ship. High authority has asserted that it is useless to try to keep facts about navy materiél secret. No such secret can be kept without depriving the men on board from efficient knowledge of the materiél, and no ship's company can be said to be efficient unless they know the weapon they are to fight with.

This model of the Monterey was highly admired by Vice-Admiral Sir Cyprian Bridge of the Royal Navy, and by nearly all the captains of the British Asiatic fleet under his command, and the writer was informed that Sir Cyprian intended to have a similar model of his flagship, H. B. M. S. Glory, built by the same Chinese carpenters in Hong Kong.

There can therefore be no objection to these models on the score of their expense nor of the publicity they may give to our naval constructions, but unless there is a demand for them by the navy it is doubtful if they will be furnished. All who desire a more thorough knowledge of our large modern cruisers and battleships surely must desire every possible facility to enable them to acquire that knowledge most expeditiously. Younger officers especially need these models, and it is just as necessary for naval officers to have such skeleton models as it is for medical students and surgeons to have manikins wherewith to study the complicated human anatomy.

The model of the Monterey has been sent to the Bureau of Construction and Repair, Navy Department, Washington, D. C., where it can be seen by our naval authorities and its necessity will be thereby apparent.

A good workman knows his tools.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVAL PROFESSION: ITS HISTORY AND IDEALS.

By PROFESSOR E. K. RAWSON, U. S. Navy.

The object of this essay is to show how the naval profession has grown to its present important position, and to set forth some ideals which are essential to it.

The naval history of England best illustrates the development of the naval profession. If any other land has records of greater antiquity, it would yet seem more profitable to study the naval history of a people whose annals are more illustrious than any other. Every page of England's history from generation to generation has recorded the deeds of her ships and her seamen in the defence of her coasts, in discoveries, in maritime industry and naval engagements. For more than a thousand years she has had royal ships, the nucleus of a navy.

Political changes, the advance of civilization, as well as scientific progress, have all been factors in giving outward form and shape to a corporate existence known to-day as the Royal Navy.

Her isolated position and her commercial interests, as well as her insular territory, have all contributed to the upbuilding of her naval force.

It has not been built like an edifice, from foundation to capstone in regular stages. It has grown, rather, like a city, subject to adversities, now flourishing, now nearly razed to the ground; whose citizens have made progress from rude conditions and humble ways of living to great and diversified possessions and pursuits.

It has had its galley period, its period when sails were used, and its era of steam. Contemporaneous with this growth of

material has been a development of the relations of officers and seamen to the service; this development, however, has not been orderly or by successive stages, but irregular and spasmodic.

To a certain extent it has mirrored the distinctive phases of society and civilization through which England has passed.

In the consideration of England naval history with reference to the development of the naval profession, there comes first to view:

1. The evolution of the ship, as representing the environment in which the profession has birth and characterization.

Changes in naval construction have had their influence in determining the character and broadening the activities of the naval profession. It is apparent that during the early periods of naval warfare, from the ancients down to mediæval times, the conditions dominating official life on board ship—such as it was, were elementary, inasmuch as the type, rudimentary and simple, remained substantially the same. The Norway Viking ship of the ante-mediæval period, dug up from the mound at Gokkstad, does not differ from the Roman galley in any material degree. In length it is about one hundred feet, the beam is about one-third of the length, sharp and high at the bow and stern, deckless, except for small covered spaces at either end, rowing sixteen oars on a side, amidships, one mast and a square sail, which was lowered in battle, her steering gear a single oar on the starboard side, near the sternpost.

The duty of the master of the ship was mainly to get work out of the arms and backs of the men beneath him. The fighting force must necessarily have been small in such a vessel, on account of its small carrying capacity. The ship was little more than a long boat—an opportunity for landsmen to fight as on shore.

Whatever progress might have been made, during ancient times, toward a definite sphere of action relative to the military officer afloat, ceased during the dark ages, and the development began anew with Great Britain about the time of William the Conquerer. The Saxon navy, if such it can be called, was simply for defense. From this time on the English Channel, from being simply a boundary, began to be a means of communication between the island and its possessions on the continent. To attack, as well as to defend, to go from home as well as to stay,

became the province of the king's ships. With enlarging territory, stronger ships were needed, and an equipment sufficient for longer voyages. Ships must be seaworthy and able to keep the sea. The care of provisions and equipment became of prime importance. The period of naval economy began: how to keep the ship, how to feed and clothe the men—diverse duties not as yet under control by one official head.

The navy as a corporate entity, a fighting force, does not exist. The English sovereign, however, owned a few ships, which, being larger than the ordinary ships, were frequently used by merchants, who hired them under conditions which brought goodly sums into the royal coffers. Richard the First in 1190 drew from all the ports of the kingdom his crusading fleet. That noteworthy movement in European history, the crusades, had its moral influence, though not apparent at the time, upon the future history of the English navy. For a navy for defence is only half a navy. The vigorous, well-equipped nation defends by offensive action. When it dawned upon the national consciousness, that for long distances, over alien seas, English ships might sail, as a fleet—an armed force afloat—with that consciousness there came the beginnings of English commercial and military supremacy and the future navy in embryo.

A significant incident of this expedition is that the king drew up regulations for the fleet, especially for offenses against life and property; for the military code must still have continued in force. Two phases of professional environment are now in view, the grouping of ships in a fleet, the king's regulations to govern each and all. But these phases are not yet united, they disappear when the fleet is disbanded, and the men disembarking are lost in the populace ashore.

For nearly two hundred years from the Conquerer's time, the sovereigns of England availed themselves of the assistance of the shipping of the Cinque ports. The men of those ports in return for certain privileges, were bound, at once to honor the king's demand for the service of fifty-seven ships for a period of fifteen days, free of cost, and longer at a customary rate of pay. Such an arrangement hindered the growth of the Royal navy; for as long as the kings could enjoy the privilege, without a direct charge upon the Exchequer and the responsibility of maintaining a fleet, a collection of king's ships to any great num-

ber was not thought of. But as England grew in power, her merchant shipping grew; this was a fruitful source of supply in ships and men for the future navy.

During this time naval construction is undergoing changes. High decks are introduced as the vessels are enlarged; fore-and-aft castles are built; the rudder begins to take the place of the steering oar; there are three masts instead of one. With the introduction of cannon early in the fourteenth century, stronger ships are required, their construction is modified, the curving of the sides takes place, the "tumble home." At first the guns are fired over the top of the bulwarks. When port holes are devised towards the close of the fifteenth century, the distinctive mark of the man-of-war appears, and with the guns nearer the line of the keel and the greater stability of the ship, the professional sphere of action, the territory so to speak, of its environment, is nearly complete.

Here we have a new phase of professional life, dominated at first by the military officer afloat, eventually to be combined with the function of the mariner. The ordnance being permanently on board ship, it became a part of the ship, as it were, and the ship becomes a man-of-war.

There is only one more advance to be mentioned which took place in the time of the Tudors. Ships of war are becoming symbolic of the nation's energy, a pride and circumstance of war are connected with them; they are gay with flags and pennants, signals are more generally used. Later the imposing figure-heads and gilded sterns are seen, evidence of a patriotic pride.

In Henry the Eighth's time, owing to the special interest which he took in nautical affairs, came a great improvement in armament; the Serpentine, a gun weighing 250 lbs. without any carriage ("the Regent carried 151 of these in iron and 29 in brass in 1501") is replaced by demi-cannon and culverins. The ship's decks are becoming lower, while the old fashioned armament, cross-bows, spears and pikes, are still used, the pikes even remaining to our own day as decorations of the mast. The line of demarcation between the new ships and the old is not distinct at this period; the old was found alongside the new in ships and equipment. This is true of all the periods of naval architecture, the introduction of steam making the most radical change. With steel and steam we have the modern ship of war.

Broadly speaking, however, the type of ship was fixed during the Tudor period as it remained practically for five hundred years thereafter.

From the simplicity of canoe, raft and paddle, to the heterogeneous complexity of the modern battleship, the development has taken place; but when the ships of the Tudors sailed the seas, the sphere of professional function, so far as it can be localized, was complete.

In order that a clear idea of the naval profession may be obtained, it is necessary to review, in the second place:

2. The growth in administration and organization which was taking place during the period of the development of the ship.

Thus far we have seen that ships for war purposes have become a distinct class, with a somewhat complicated equipment, as it relates to ordnance and seamanship; but there was no navy properly speaking in England until there came, in the process of time, something of administration on the part of the government and of organization aboard ship. The king, while generally possessing a few galleys, as has been said, simply hired ships for great emergencies. Over these ships he could not be expected to exercise special control. And yet, let us remember that the crusading king, Richard the First, drew up regulations for his heterogeneous fleet. In the union of these two conditions we have the germ of the naval profession: a special ship and special regulations; a sphere of action and an orderly system.

Under King John, who died in 1216, there is the first hint of a naval administration, in the establishment of an office called "The Keeper of the King's Ships." This officer was designated later as the "Clerk of the King's Ships," and his authority was pre-eminent until the establishment of the navy board in 1546, which ended the mediæval regime, gave permanency to administrative authority, and ensured a navy as a permanent institution.

With a definite administration and organization, the military officer afloat came into relation with an official representing the royal power, to which he became responsible, under whose supervision he performed his duties and made his record whether for good or ill. Under various names this official appears in English naval history, with varying function and authority, until in a descent more or less regular, his duties are performed by a secretary of the Admiralty or the Lord High Admiral of the present time.

As early as the reign of King John, (1199-1216) there was a partial naval organization, as it were an approach to a navy. It was apparent at that time that the king was exercising authority over a fleet, and that the fleet represented the monarch who is sovereign in authority. When that authority shall come to be regularly and permanently exercised over a number of ships, and when it shall be recognized as obligatory by the commanders of ships, when further foreign ships shall recognize the royal power afloat, then the Royal navy will be no longer in an inchoate or progressive condition, but will be complete and worthy of the name. When King Edward the Third, who died in 1377, commanded in a naval engagement, there came with his title "King of the Sea," a new significance to the naval arm, hardly, however, an appreciation of its value, yet it had royal prestige and sanction. The ship is still a transport for armed land forces. As before intimated, when the special object for which a fleet had been gathered together was accomplished, immediate disbandment took place, until as time went on the necessity for such a force of ships and men and its preservation in peace, as well as in war, dawned upon the monarch's brain.

To this end, in 1212, the docks at Portsmouth are ordered to be enclosed with a strong wall, for "the preservation of the King's ships and galleys, and pent houses are to be erected for their stores and tackle." In Henry the Eighth's time a dock was built at Portsmouth at an enormous cost—ships are of greater value, conveniences for repair must be adequate. This is a mark of naval permanency, and ensures continuity to the service.

Previous to this event, the growth of commerce in the reign of Henry the Fifth and Henry the Sixth, 1413-1471, developed a larger shipping and rendered necessary a protective power.

The desirability of a permanent set of ships, that is a navy, is becoming increasingly apparent. A navy is recognized as a military force, not only to make war, but to protect commerce as well. The ships of the crown are largely increased in number and size. They are, however, and continue to be, until the Protectorate, 1649, representative of the monarch rather than of the nation. They are the king's ships to dispose of as he would. Some of them of the size of four hundred tons are valuable to let for commercial purposes. Thus they increase the king's assets to a greater degree than ever before.

In the reign of Henry the Eighth, 1509-1547, an elaborate set of fleet regulations are prepared by order of the king: "A book of Orders by Sea and Land," the precursor of a long series of regulations, the changing constitution of the navy body politic in Great Britain.

Regulations tend to unify military service and to make the discipline uniform. Hitherto the saying "different ships, different ways" must have applied in great diversity of custom and regulation. The naval service is becoming homogeneous through every fleet. The type of naval officers which is appearing will be influenced by this condition of things. There will be similarity of plan and purpose controlled by naval law.

During Elizabeth's reign, 1559-1603, the naval force was enlarged and enriched for a long period. Evidence of cupidity on that monarch's part, as it was without doubt. Nevertheless the "spacious times" witnessed with its enlargement of ideas when England ceased to be insular and became a world power, a unification of the service which is remarkable. If Henry the Eighth created the navy, Elizabeth aggrandized it. The air was full of great enterprises. The haughty claim of the English monarchs to the "sovereignty of the seas" asserted since the time of the Edwards, three centuries before and continued down to the reign of George the First, could not with certainty be maintained by any of them. Of no English monarch until Elizabeth could it be said that during his reign the English flag had been supreme in its sovereignty over the English Channel.

One great event in Elizabeth's reign, the defeat of the Armada in the memorable year of 1588, put the finishing stroke to a work of many centuries, the value of a navy to defend and protect the national life became apparent to all men. Henceforth there cannot be any retrograde movement. The navy has come to stay.

Time, which moulds states and nations, has at length solidified and made compact a military force upon the sea through a continuous period of forty-five years. The navy has attained its majority, henceforth it will bear its own responsibility in the affairs of the nation.

So the administration and organization of the navy was achieved for the English people through many efforts and contributory causes, the most salient of which are the establishment of rudimentary regulations, the appointment of a shore

official to exercise supervising care, the consequent feeling of responsibility by commanders of ships, the identification of the king with a fleet evidenced by his taking personal command, the recognition of this fact by the nation at large, the necessity for a place to construct and repair valuable ships, the awakening to the need of a permanent number of ships under the control of the sovereign, the completion of a code of regulations making discipline and procedure homogeneous, the aggrandizement of the service through the freighted wealth of an age of discovery and commercial enterprise by sea.

It only remains to consider the relation of the officer to the ship and to its organization and administration as constituting his professional life.

3. The development of professional function.

When the navy as an organization began to take shape, as far as the handling of a ship is concerned, the captain of a king's vessel differed from the captain of a merchant vessel very little, they were equally good seamen, in fact the offices were interchangeable. Command of each kind of vessel was assumed as occasion arose. Their status was differentiated only in this that the captain of a king's ship regarded the king and "the Keeper of the King's ships" as sources of authority and himself as representative of that authority.

With this responsibility to an authority distinctively naval the character of the profession secured a mark of relation. Whatever authority in independent command an officer might have, his acts are now scrutinized and comparisons are now made between him and his brother officers which raise or lower his professional standing. Responsibility is made to have close relation to a supervising power.

The systemization of duty embodied in regulations began early in the history of England's navy. No sooner were they compiled and promulgated than the officer afloat had guide and direction for duty, a standard to which he must conform and by which he is judged. He stands now in a twofold relation on the one hand to a supervising power above him and to an order of duty, and an ethical standard surrounding him, making limits to the sphere of his activities and tests for his official conduct. The character of his profession is in process of definition.

But "the Keeper of the King's ships" ashore evidently could

not well attend to the duties connected with many ships at sea,—a fleet, hence the necessity for the office of the admiral which had its beginning in the thirteenth century. It was not originally an office of any permanence and was held as "a mere court title of honor." In the fifteenth century the title of Admiral of England was given to an official in command of several fleets at sea, but with the stay of hostilities his title relapsed. His duties were simply militant, not administrative, as far as naval matters are concerned. Afterwards there was added to his responsibilities judicial functions in the hearing by deputy of maritime causes of a civil and criminal nature, hence Admiralty Courts. Later executive and administrative control came to the Lords Admirals, though as late as the reign of Henry the Eighth the Lords Admirals were not required to have had actual experience at sea, before appointment.

Naval historians are not clear as to the precise date when the Admiral became a sea officer pure and simple. In 1596 there is mentioned the "earliest distinction of squadrons by flags." Oppenheim says the Cadiz fleet of that year had four large flags, one white, one orange tawny, one blue and one crimson. Afterwards the well-known threefold division of red, white and blue came into existence. Not much, however, of distinctly naval character could have been included in the office, for as late as the Commonwealth we find the renowned Blake, who had won military distinction on land appointed "Admiral and General at Sea," with no experience of ship life or knowledge exclusively nautical.

With the historic moment of the advent of the Sea-Admiral whenever that may have been, came that authority in administration, that compactness in organization, that uniformity in discipline without which a fleet is simply a heterogeneous assembly of ships, valueless in warfare. The naval officer now comes into more direct and nearer relations to a superior authority, and the office of admiral requiring larger executive control and a knowledge of tactics and strategy, the professional function is thereby enlarged, receives greater dignity and requires greater ability in the individual holding it.

Professional character as far as ethics and refinement in the English navy was of slow growth judged by the standards of our own day. In the early history of fighting ships privateering and

piracy were frequently resorted to. Piracy was more profitable than commerce when friend and foe were alike despoiled, as was frequently the case.

Just before the Armada fight in 1556 privateering was encouraged by royal proclamation. This condition of affairs tended to official demoralization. An historian * writes:

"When we find a privateer belonging to the Lord Privy Seal attacking neutral vessels, and man-of-war officers boarding and robbing a Flemish merchantman at Tilbury, it seems wonderful in view of the excesses such incidents suggest among the majority with no sense of legal responsibility that commerce could have been carried on at all."

The disposition to add to one's pay by irregular methods was long prevalent. Insubordination was not infrequent. The first case of a trial by court martial for this offense occurred in Queen Elizabeth's time, in the year 1557. The morals of these early commanders, in the reign when the navy was fast assuming shape, were the morals of irresponsible men many of whom were chosen mainly for their seaman-like qualities, whose lives would not bear looking into, who from early boyhood, with little education and naval training, had followed the sea for a livelihood.

The establishment of the navy board in 1546 tended to bring this lawless element under control, with varying success. Public opinion was needed and naval opinion as well, to demand a better and more select class of men. England, however, slowly appreciated the value of a navy, and only as the nation began to understand its importance was the attention of men of character and of standing attracted to the service afloat.

But the adoption of certain administrative measures from time to time as necessity required have been formative influences in shaping professional conditions, and in elevating professional character. The fact that in Henry the Eighth's day the Lord High Admiral, the "King's lieutenant for sea affairs," gave commissions to military officers is of marked significance. Presumably such men were far above the average, if thus chosen, and men above the average as they were dignified men, dignified the profession. They enlarged its demands upon the individual. Their successors were required to come up to a high standard for they had set the mark.

* Oppenheim.

At the same time, and this is of consequence, the appointment of non-military officers came under the navy office. The seamen branch of the service. Such appointment by navy commissioners illustrates the value to the service of men who had the benefit of personal experience at sea. Especially in Cromwell's time were the navy commissioners men who knew the sea and the importance of choosing men of skill and integrity as officers.

In passing, it is worthy of note that seamen have made the service, that is shaped its naval character, very largely. As soon as they have come into positions of executive authority and have become cognizant of the needs of the service, it has through them received development. Henry the Eighth was fond of the sea, "an amateur yachtman," if no more, his work was far reaching in the upbuilding of the navy. This is true of the service in the days of the Protectorate as well; when seamen were well cared for by those who had been at sea, who knowing the wants of seamen respected their claims to good food and prompt payment of wages, and were not slow to hold officers to a strict account for their conduct.

The great names of the nobility in Elizabeth's time who sought sea service to repel the Spanish Armada, their distinction, is evidence that when the time is fully ripe the navy will find its quota of loyal adherents composed of men of station rather than of mere adventurers.

As yet the status of seamen was low. Roughness, ignorance and immorality characterized them. It may not be too broad a statement to make that with the care and respect for seamen there has kept pace an elevation in naval professional standards. Suffering under the rule of both King and Parliament the sailor would rather be "hung ashore than starved at sea" as the saying was. Nor could the flogging and keelhauling and other brutal punishments of the man enhance the professional dignity of the officer. But what can be expected of seamen of whom Raleigh is quoted as saying: "They go with as great a grudging to serve on his Majesty's ships as if it were to be slaves in the galleys." It is doubtful whether under these stringent circumstances, religious services twice a day, and the singing of psalms at change of watch, which in the times of James the First, "was an old custom," ever availed to console the seamen for rations of bad beef and sour beer.

It is to the honor of the Commonwealth that in its day provi-

sion was first made for sick and wounded seamen and for naval pensions.

There has not been any continuous progress in naval professional development without retrogression in the earlier stages, often what one reign accomplished, was lost in the next. As a general rule, the character of naval officers has represented the state of social refinement of the period, and to some extent the dominance of the reigning sovereign. Henry the Eighth fostered the navy. Elizabeth utilized it for her own purposes. Cromwell strengthened its discipline and morals.

Cromwell not only infused some of the discipline characteristic of the Puritan army, he also gave a new significance to the service in making it a world-wide arm of the government, establishing the Mediterranean Squadron and also squadrons in the West Indies and North America. The changing character of the service demanded a new and stronger type of officer, one to be trusted with the care of ships and men at a long distance from the home ports. The navy is no longer a small force hugging the island coast, but a large force to attack and defend in far away seas.

Then for the first time there is a regulation requiring a ship's log, an important part of professional procedure which is to be "turned in" on the return of the ship.

During the Protectorate also there is the first record of a captain being summoned before a court, his ship having gone ashore although she floated again without injury, evidence of the tightening of the cords of official restraint. The pressure of official restraint always has the tendency to sharpen the professional conscience and to elevate the standing of professional life.

During the time of James the First there seems to have been a regular corps of officers established and the navy became consolidated into a condition which, most largely developed in the time of Charles the Second, remained until the advent of steam and steel. With a corporate existence there is the possibility of *esprit de corps*. The profession has assumed a fixed form to be seen and known of all men. It is an interesting coincidence with this genesis of the profession, that from the close of this reign, the historians date the beginning of modern England.

The outward form is now present. A fleet divided into rates. Officers chosen with care, under the supervision of Lord Howard of Effingham and Earl of Nottingham, Lord Admiral of England.

for their quality and experience. For a generation after his command of the fleet in 1588 which destroyed the Armada, he gave his attention to the service, especially the personnel. A navy is simply an organization of men and ships. This has been achieved.

It was only by the hardest efforts that the followers of the sea obtained official and political recognition. Out of sight, out of mind, was the political fate of the nation's servants at sea. Whether this neglect, illustrated constantly in the English navy, has been responsible for breaches of trust and other military offenses, it would be hard to say, but it is certain that even with a well-established navy in the period of the Commonwealth the great number of courts-martial for serious offenses show that "professional honor was not yet a living force."

And yet during these very times there was a high sense of naval discipline and honor exhibited by Admiral Blake who did not hesitate for the good of the service to bring to court martial some who were very near to him. There is now the thought in the naval mind that the service is of value. The evil doer is summarily dealt with.

In 1652, the first articles of war were promulgated on December 25th: they numbered thirty-nine. At last the navy has a code of discipline established by the representatives of the people in Parliament assembled. The punishments for offenses contained in them was severe, a large proportion requiring the extreme penalty. The sense of professional honor had grown keen, it must be maintained by officers, and men as well, otherwise degradation, dismissal, or death confronted them.

These articles of war are supplemented in the reign of Charles the Second by "two sets of orders." . . . The first contains the "general instructions" addressed to each captain, and consists of forty-four articles. The second is headed, "Orders established for the well governing of His Majesty's ships,, and preservation of good order among the respective commanders, officers, and seamen serving His Majesty in the same." These orders were issued by the Duke of York and are referred to here to illustrate the growing vitality of the navy in discipline and organization. Order and system ashore on the part of the authorities, order and discipline on shipboard, assured to commanding officers regularity of administration and procedure which like well-worn roads facilitate professional progress. When it is considered that the naval

officer is nothing, if not a seaman, the low estimate in which the requirements of the profession had been held up to the reign of the Merry Monarch is very strange. Hannay quotes from Boteler's Dialogues, "probably written in Charles the First's reign," a conversation wherein the speaker says "it is proposed as if there was some novelty in the suggestion that no man should be appointed captain until he had been at least one voyage to sea."

But there was need of training for sea-officers. Seamanship had become a complicated art since the Tudors. This is the function which is characteristic of the profession. There is a great advance upon the one square sail simplicity of earlier times and the row of oars of the galley period. From Henry the Eighth's time and on, ships became more complicated than before, and the art developed rapidly. Complicated and cumbrous the ships appear to modern eyes with their forecastles, poops and poops royal, bow-sprits and sprit-sails. In this reign four masts were in vogue and the high poops and forecastles were cut down. It is supposed that the topmasts were fixed and that the fixed and running gear were not unlike that of to-day.

The progress in shipbuilding demanding greater knowledge in the sea officer, marks a professional advance. Ships are working more closely to windward than ever before. The master mariner must be a man of parts, a thorough seaman, and know his own ship. But the military phase is still dominant, as late as 1514 the fleets carried a "Treasurer of the Army by sea."

It is noteworthy that with the advent of sail power in large extent the function or duty of the sea officer enlarged and with it side by side came the influence caused by expanding territory and possible wars, which made it desirable that the king should have ships and men to fight them, subject to his immediate orders. The military man afloat is in process of being superceded by the fighting seaman. The adventures, the discoveries, and the wars of the Tudors, all contributed to this result. As yet the naval captain has not appeared. Nevertheless the beginning of official rank is at hand in the time of Charles the First, for lieutenants were then appointed with the avowed purpose "to breed young gentlemen for the sea service," * * * "there hath not been formerly allowance for lieutenants whereby gentlemen of worth and quality might be encouraged to go to sea." The position seemed to be that of a midshipman, though the title and the name

as applied to an officer in line of promotion came later, about the year 1661, when those young gentlemen first known as "King's Letter Boys" were afterwards called midshipmen.

A significant advance is here apparent in the profession. The naval officer has come, he must be well-born, a gentleman, and he is put aboard ship to be bred for the sea service. Personal qualities and position united with discipline and training must hereafter characterize the naval officer. This was an initial step having results that have never ceased to be felt in professional standing.

It has now been shown how gradually the dignity and sense of honor, the soul of the naval profession, has been developed, and also that in the lapse of time there has come the beginnings of the naval officer, the commencement of promotion, in the permanent establishment of young gentlemen on boards ships of war. This consideration of the evolution of the profession thus terminates.

There is yet to consider the individual in relation to his profession, the motives which should actuate him and the individual excellencies he should strive for, in other words, the ideals of the profession.

To briefly summarize what has gone before it may be said:

When in the process of the development of shipbuilding, portholes were cut in the sides of ships the navy as an independent military organization came into being.

When armed ships passed from private ownership to public permanent control, the navy as a part of the war force of the nation first had existence, through ordinance and regulation.

When first the functions of the seaman and the military officer were united in the captain of a ship the naval profession took form.

When the naval officer became a component part of an organization continuous, permanent, then his profession having opportunity and the future in which to grow began to take a permanency of form, tradition carried custom from generation to generation of seamen, and custom hardened into regulation and law.

When gentlemen became officers and commanders of ships, the nobility in its highest rank recognizing the navy as an opportunity for a career, then it was that the service received professional dignity. This dignity was increased as it came to be clear that the navy was of great importance as a field of warfare. Profes-

sional scope was enlarged. Large questions of strategy hung upon the movements of ships. The saying of Sir Walter Raleigh that "England is a country that can never be conquered while the sovereigns thereof have the command of the sea," began to be realized as a truth.

Until the modifications introduced by modern science in the 19th century, no one particular cause sufficed to change naval conditions, many causes contributed, the desire for efficiency influencing officers high in command, and statesmen also, the naval service was gradually added to in compactness of organization; regulation and traditions of discipline making a body of naval law;—*corpus navalis legis.*

The standard of official position, of professional attainment, was therefore measured by compliance with naval opinion as to what constitute official value. Under these new conditions arose a manifestly higher standard than that which governed the adventurer who took command of the king's ships in early English naval history.

II.

PROFESSIONAL IDEALS.

While the material with which the naval officer has to do has become increasingly complex, witness the ancient war canoe and the modern battleship, professional standards have risen in as great a contrast.

With the disappearance of the military officer at sea, responsibility no longer divided, but in the hands of one man, the double function taken up, the naval profession on account of the multiplicity of its relations assumed a new enlargement and importance.

The naval officer has always a two-fold relation and responsibility, to a sovereign power through the organization representing it above him, and to the multitude of subordinates under him.

In addition to seamanship and gunnery as arts, the discipline and morale of the service requires his constant serious attention.

New conditions have not altered these fundamental characteristics. Modern science has only enlarged and made more complex and powerful agencies which have always existed in simplicity. Modern civilization has demanded greater refinement of character and manner. Professional necessities have required

an enlarged and thorough technical education. It is concluded then that:

The naval profession is a special scientific technical pursuit of a military character.

Knowing its growth and its character, we ask now what should be its ideals?

They should be those which are professionally characteristic. That is obvious. But while the profession is unique, it is not an exotic.

It has common grounds with all professions when personal characteristics of mental discipline and morality are concerned.

But all its ideals are subordinate to one main ideal which represents the chief aim of the profession:

Efficiency in battle on the sea. That is the *summum bonum*, the naval profession's ultimate aim, to which all else is subordinate, to which all agencies and endeavors converge.

As preliminary to a consideration of professional ideals some observations upon the naval profession as it exists to-day may be worthy of consideration.

A profession is simply an environment in which a man works. It defines his activities and delineates them. It is like a mold through which the ardent currents of his activities run, as in the iron foundry the molten mass runs with more or less heat and purity of substance, until at last, like the ore, he is settled into hardness and becomes an exponent of his profession, such as he may be.

In the process of development when the mental predominates over the physical, the handicraft becomes the art, the industrial art or the technical trade becomes the profession. The professional man does not use the handicraft nor the industrial art but utilizes them. The line of demarcation, however, is not distinct.

It is apparent that naval ideals must be those pertaining to scientific pursuits, but these are customarily considered on the practical side and are frequently discussed and written upon. There are subjective and personal ideals which are of equal importance.

The profession has a two-fold character, the military and the nautical. We know then that the ideals must lie in these directions; but it has one characteristic more than most professions; it has an administrative character. It is perhaps this which distin-

guishes it from all others (except the military) as does the nautical phase.

It is therefore unique among the intellectual pursuits of men. While it is essentially military, that is it has to do for its main end with warfare, it has to do also with an unusual sphere of action, the sea; and with a most complicated machine, the ship. And the profession, by reason of the limitations of human nature requiring shore duty, therein requires and it may be develops, a business capacity, an administrative, organizing quality of mind, in addition to administration based on organization exhibited at sea.

How is it differentiated from other professions, especially those called the learned? Advancing civilization and improved education, with the demands of modern science, have rendered necessary that theoretical preparation and training of mind which requires careful education through a prolonged period; this formerly was the exclusive prerogative of the minister, the lawyer, the physician; the term learned might therefore properly be applied to the naval profession were it not for the fact that in these days all professions require education and training, the appellation of learned is therefore becoming obsolete. Yet there is a sense in which it is different, in that the former professions are learned as far as theory is concerned, mainly from books; but with the military professions theory and practice go hand in hand in a peculiar manner and are not independently carried on, but always under authority.

As before alluded to, the chief aim, the goal of the profession to which all things radiate as to a center,—the essence of the naval profession is military. It is always a preparation for a great event. It has no reason for its existence otherwise. Its highest goal is victory. For that material and personnel must be combined in perfected action.

The naval profession exhibits the law of evolution from simple homogeneous conditions to those which are complex and heterogeneous. From the simple canoe or bireme of the ancients, to the cruiser and modern battleship, there has been gradual development, with this development, keeping pace with its growth in material, professional agencies have multiplied and professional requirements have become manifold.

The marvelous discoveries of science have been gathered up for the utility of the naval service. They have been added to the

simpler relations of earlier days. Into these new channels professional aims and energies have run, the life of the naval service has received the new influence as a flourishing tree receives the flowing sap in all its branches.

Among the forces of civilization as it progresses with increasing purpose to the federation of the world, the naval profession has its place. It is a check upon disorderly and uncivilized outbreaks the world over; and is a representative of power no longer monarchical and despotic, but largely democratic and liberty loving. This may fairly be said, for the nations of the larger navies fulfil that requirement in their political status.

As far as military force is considered the naval profession is in the forefront of existing attacking agencies. The rapid mobility of the navy, its world wide range renders it indispensable in any military strategy and the commercial interdependence of nations as far as food supplies and munitions of war are concerned renders it a most effective siege weapon in blockade. The essential value then of a profession having to do with an agency upon whose efficiency the very existence of a nation may depend is beyond question. But while the value to the nation is great, its professional exactions are severe and serious.

So we find that the captain of a modern battleship to-day is the resultant of constant and varying tests, physical, mental and moral. Intellectually he will be found to be of a high order, physically capable, having endured the strain of fatigue and climate, morally unexceptionable.

There is committed to his charge a machine complicated and powerful, crowded with motors and appliances possessing Titanic forces in potential energy almost beyond conception and computation. To its building years have gone and vast sums of money. Amounts which would have built fleet upon fleet in the navies of the Tudors. Its personnel is large and varied, officers of graded rank and experience, men of training and skilled labor. All these dwell in the home of the ship; and the domesticity has to be cared for with all its variety as well as the practical training. This is his professional habitat. Here justice has to be administered and just as the old patriotic Roman took care lest anything of detriment should come to the republic, so ever and always the captain takes heed lest any detriment should happen to his ship.

And well he may, for upon no other man in any profession can

there fall a tithe of the responsibility which the exigencies of war may lay upon him. It may well be that in a conflict his skill and coolness may turn the tide of battle when it thunders all along the line, thus saving a nation, or it may be that from error or failure of the slightest he may lose some "Victoria," suddenly sinking in the manœuvres of peace. An appalling responsibility! By some sad blunder a great battleship costing millions in gold, enshrining a thousand brave, gallant, generous, precious lives, by one error disappears beneath the vast unconcern of the sea.

And, moreover, although it is a truism, it must be remembered that his knowledge of the element in which he lives, fitful, changing, powerful, destructive, must be complete. He must know the hints of the coming storm as it gathers in blackness, and must be imperturbable when "no small tempest" lays upon him its rough hand and asks him to show his manhood and his skill.

But now we revert to the question:

What should be the governing principles or ideals of the naval officer in the practice of his profession?

To him has been bequeathed, the inheritance of generations of sea-faring men for a thousand years, a profession in whose pursuit all his energy may be employed. What will he do with it? Many are the channels for the exercise of his faculties. There are those, however, he cannot overlook, special ideals which should influence him, of great importance, not to be neglected under penalty of certain failure.

Let him seek first for

1. THOROUGHNESS.

An obvious injunction! True, but always in order. True of every profession and of every walk in life. Eminently important when it is considered that a naval officer always stands for some one else than himself, for his people, for the nation. It is not optional with him to fail, and suffer for his failure if he will. He is bound by solemn obligations to do his utmost in defence of his country. But argument is not needed here. That attitude of mind which concentrates activity upon whatever occupies it to its full understanding and complete carrying out, that is the thoroughness which is needed.

If it is exercised during the time of formal educational preparation it results in a foundation upon which the superstructure of professional success is sure.

There is nothing which contributes more to that self-reliance which is indispensable to the naval officer than thoroughness in education, in the performance of duty, and in variety of experience.

It is the basis of professional character. There can be no self-reliance without this quality. The hidden cause of the lack of initiative, which lack is a bar to professional success, is the self-distrust which checks the flow of activity at the fountain-head.

A habit of thoroughness causes a man to feel himself master of the novel situation which suddenly confronts him. To him it is an opportunity—a doorway to success and reputation. To the man who distrusts himself, knowing the weak joints in his armor through deficiency in preparation, the situation is a gulf in which his professional self-esteem sinks in uneasiness and shame.

No one who has the efficiency of the naval service at heart should ever forget that it is only by the most conscientious thoroughness in daily discipline and attention to detail, through long periods of time, that success in warfare is won.

1. As an adjunct to this quality of thoroughness it must be remembered that completeness of culture is needed.

For culture the old definition will suffice: "to know the best that has been thought and said in the world." President Eliot's description of the cultivated man is expressive: "he is to be a man of quick perceptions, broad sympathies and wide affinities, responsive but independent, self-reliant but deferential, loving truth and candor but also moderation and proportion, courageous but gentle, not finished but perfecting."

A man must sail away from his home port for the *spolia opima* which are beyond his immediate horizon in order to make him rich in his own right.

Other streams must be made tributary to the main professional current. No professional pent up Utica should contract his powers, for in more senses than one he has the unbounded world for his domain. Let everything be grist which comes to the mill of his professional activity to be ground out into the finest wheat for his sustenance.

He is the best naval officer, to use a paradox, who is something more than one.

2. As an incentive to thoroughness, interest in the profession is imperative.

An intellectual interest without which the profession is cheated of its first due. Unless that interest be present no one is a proper judge of the value of the profession considered merely as part of the intellectual life which every thinking man leads. There is variety sufficient to awaken this interest in minds that have any scientific inclination. The artistic temperament will find little nourishment. If interest deepens into enthusiasm then thoroughness comes as a necessary concomitant. If a man can only awaken a professional enthusiasm his success is assured, but, alas, enthusiasm in life is a rare quality.

3. In connection with completeness of culture, an essential part of professional thoroughness, a military use of the imagination is needed for the highest professional standing.

Disraeli affirmed that, "of all the attributes of a statesman, imagination was one of the most important." Probably the remark was not appreciated.

When the imagination is confounded with reverie its use is considered folly, and rightly, but Tyndall in his essay on the scientific uses of the imagination has shown its great value. When imagination is defined as "the power of forming with indescribable swiftness a true mental image of the result of calculated causes," its value is apparent, not only politically and in warfare, but throughout the multifarious circumstances of a naval officer's career.

Hence the advantage of literature, biography, history, and above all military and naval history, for the naval officer. To make it possible for him to get out of the dead level of a conservative iron-bound practical present into the possible future where the work is done for which the present day is only a preparation. This may be considered by some a "counsel of perfection," but it is not. Imagination is one of those qualities to be cultivated by which men make themselves superior to the majority of their associates, rising above them as the stag with branching antlers stands above the common herd.

When this faculty attaches to inventive skill, of which it is the vital principle, its value is appreciated, though equally appreciated to-day in scientific research; but in matters military it has a chief though as yet not a fully recognized place.

In a game of chess, the man who sees a little farther, one or two moves, than his adversary, the long-headed man whose brain

grasps more of the possible combinations, that man wins the game. But remember, warfare is also only a game.

4. In order to thoroughness, there must be identification with the service. Part and parcel of it a man must be. There must be no divided allegiance, no longing for the flesh-pots of any civilian Egypt as he starts out for the promised land of professional success, not like Rodney, "who in the matter of community of sentiment," Mahan writes, "stood habitually external to his profession; in it, but in heart not of it; belonging consciously and wittingly to a social clan which cherished other ideals of life and action;" but like Jarvis "at all periods in thorough touch with distinctively naval feeling, sympathizing with and respecting its sensibilities, sharing its prejudices, as well as comprehending its weaknesses."

The law may be "a jealous mistress," but Neptune is a stern despot, and woe unto any half-hearted subject who attempts to escape the sway of his trident.

There is another quality which is characteristic of the military professions. The executive faculty as seen in

2. AUTHORITY, OR THE POWER TO COMMAND.

Of this professional function it may be said that while an authoritative manner may be an inherent part of an individual's nature, the faculty of command may be disassociated from it, and is in large degree possible of acquisition. The commanding presence under modern conditions is no longer of the same value as formerly.

The power to command is not the power merely to issue orders. It consists in an intellectual grasp of the situation and the persistent will power to meet its emergencies. Without these there can neither be proper execution nor administration.

The naval officer must know what ought to be done and at the same time must will to have it done.

As far as administration is concerned, to command well he must have that attitude of mental scrutiny which will lead him, as has been fittingly said by Herbert Spencer, not "to suppose things are going right till it is proven they are going wrong; but rather to suppose they are going wrong till it is proved they are going right."

In order to the exercise of this faculty, he should understand

human nature; he must be quick to recognize the various dispositions of men, the sensitive, the indifferent, the intelligent; insofar as he fails to do this his power of command fails.

At the basis of all authority aboard ship there lies the character of the officer exercising it, and the counter respect for his professional ability from those upon whom it is exercised. If either of these conditions fail the value of authority dwindles. Some little gleam of it lies in the office, but it differs from the real thing as a ghost differs from a giant.

If the will of the ranking officer is to be carried out, he must have a will.

Those men make the best naval officers, as far as power to command is concerned, who have a clear idea of what they want to do, a concentration of mind upon it, which vitalizes the will, and some strong red blood in their veins as motive power. If in addition to the ordinary mental powers referred to, a naval officer has an attractive personality, then his power to command is greatly enhanced; or if he has that magic power over the souls of men by which men thrill at the mention of his name, the exercise of authority is hardly needed for it is felt without being manifest, and men accomplish that which is ordered enthusiastically and well, under discipline and without specific direction. Such was the influence exerted by Nelson, who had a great soul in a little, not to say insignificant, body. Mahan quotes Admiral Jervis with regard to the gallant conduct of an officer at the battle of Algiers, "He seemed to have felt Lord Nelson's eye upon him."

Said Wellington, "You can only govern men by imagination; without imagination they are brutes. 'Tis by speaking to the soul that you electrify men."

Not only human nature, but seaman nature, must be known by him who would command. And the study of human nature is only pursued through the channels of sympathy and imagination. Men are neither brutes nor machines. You cannot beat obedience into them, nor perpetually drill them like machines. Obedience must be won by sympathetic treatment, fairness, constant executive pressure until obedience is automatic, but never unthinking. Otherwise remorseless routine finds itself incompetent to work with novel situations and unforeseen circumstances. It has been said that "Germany not only expects every man to do his duty, but she drills him until he forgets how to do anything else."

This is apparently the acme of official desire.

But as the grade of manhood and intelligence grows on shipboard, as new conditions enforce it, there is the individual with his initiative and his humanity to be taken into account. The higher qualities of patriotism and pride in his pursuit must be considered. The nation which has men drilled not only to do their duty but to do their duty, when, so to speak, there is no more duty to be done, is the nation which wrests victory from the jaws of defeat. The qualities of pride, of initiative, of enthusiasm, are begotten in men by commanders who have sympathy and imagination, and victories have been known to be won by inferior forces on the sea as well as on the land; but never by men who lacked in these qualities which are superior to mere routine, as the soul is superior to the body.

No nation can attain or hold the command of the sea until its commanders know how to command the men of the sea.

3. MORAL COURAGE.

Physical courage is such an apparent component part of a naval officer's professional requirement that it needs no mention, while the equal, if not greater, need of moral courage is not so well recognized.

(1) Professional moral courage is that courage which opposes equally the non-moral and the immoral as far as it affects professional life.

Out of the root of custom comes law, and out of custom and law come morals.

"Regulations" are the professional moral laws. They are non-moral from the point of view of the general public rather than moral. They are moral, however, to the officer, because they refer to matters exclusively in his domain, and because he is bound thereto, not only by professional obligations, but also by the sanction of a special oath.

There is a region here where there is room for keenest judgment and highest character. That region where the best constructed rules, owing to the inadequacy of language to cover all cases, are capable of a two-fold interpretation, where the spirit and the letter of the law stand before the individual's judgment, where a man shelters himself behind the letter and violates the spirit, or where he courageously carries out the spirit as superior to the let-

ter. These tests show professional fibre. To meet them, the individual must be both strong and yielding.

(2) There is another field for the exercise of this rare and sterling quality of character besides that of interpretation of regulations. It may be recognized in matters of administration or of an executive nature.

Where these are concerned, it is easy for the weak man to shelter himself under the protection of routine and the letter of regulation. The temptation is to fail thus in duty. Duties are uncared for, and left undone which would only be discovered under closest inspection, an inspection which they are not likely to obtain. So the temptation is to compromise with one's professional conscience, to the injury of both conscience and profession.

(3) Moral courage is a criterion, to judge of professional standing as it relates to the *Power to bear responsibility.*

This power, which is vital to professional success, is possible only when there is a consciousness of thoroughness in professional training and of such practical experience as to give familiarity with ordinary conditions.

The ordinarily successful officer bears the same burden of responsibility with the consciousness in the background of advice at hand in case of emergency. He is equally able to bear the burden of the ordinary emergency when the responsibility falls wholly upon him. But with the extraordinary test the superior man finds his shoulders broadening as the sphere of his responsibility grows larger and heavier, although he may not know how or why he should rise to the emergency or bear unflinchingly the responsibility, succeeding where others fail.

Talent and character and professional thoroughness are the components of his strength. This broadens his mental power and accredit him to his position.

Of Admiral Hawke, Mahan says, "One quality absolutely essential, and in which most men fail, he manifested in high degree. He feared no responsibility, either towards the enemy or towards the home authorities."

There are two instances in the life of Nelson, which illustrate the value of this professional principle. The well known instance of his experience in the West Indies in his early career, where he observed and fought against the scandalous practices of contrac-

tors, the violation of the Navigation Act by prize agents and others connected with the naval service. The amounts which the British government lost rose up into millions of pounds. He was set upon, besieged and annoyed by these speculators. Writs making him responsible for large sums of money were executed against him. On his return home he thought of fleeing to France to escape these persecutions and even of resigning from the service. His enemies prejudiced him in the opinion of the admiralty, a prejudice to his detriment which took years to overcome. The experience was a severe one, but he did not shrink from the responsibility which brought him no glory.

The second instance is the familiar one at the battle of Cape Vincent, when, at the risk of failure, Nelson disobeyed the signal to tack ship and immediately wore, bringing his own ship against great odds, with the result of an unparalleled success. Two Spanish ships and the sword of the Spanish admiral, Collingwood coming to his aid, were the rewards of that day, although his own ship, the Captain, lost her foretopmast, had her wheel shot away, and had neither "sail, shroud or rope" at the end of the day. Glory enough came to him this time and the decoration of the Order of the Bath.

It is too much to say that the bearing one responsibility helped him to bear the other? The power to bear responsibility is a mental attitude, and it makes but little difference whether it opposes entrenched wrong through a long period in administration, or with rapid decision attacks, contrary to orders, Spanish men-of-war.

If failure had come to him, professional reproach, loss of reputation and probable loss of commission would have been his lot; but these he rightly risked. Irving, commenting on the death of Lawrence, of Chesapeake fame, said: "He who would greatly deserve, must greatly dare, for brilliant victory is only achieved at the risk of disastrous defeat."

This power to bear responsibility is essential to military character, a truth which the shrewdness of President Lincoln was quick to perceive. It is told of him that when General Grant was appointed to supreme command, President Lincoln replied to the inquiry of a friend with regard to him: "He is a general!" All the others when appointed, said the President, came to him with their plans of campaign, as much as to say: "Now, I don't

believe I can do it, but if you say so, I can try it on, and so they put the responsibility of success or failure on me."

(4) There is a great need of moral courage in the relation of the junior to the senior, which is not often exercised through timidity, or a fear of rebuff. The above-all-no-zeal* attitude, which checks the junior's initiative and wounds an ardent spirit, should not be assumed. This is a grave professional wrong. There is a certain improper forwardness which merits checking by a senior officer, but there is a duty on his part to listen to suggestions and act on them, if meeting his approval. Proper representations are always due from the junior officer by way of suggestion, whatever risk he may run of official coldness or rebuke. Furthermore, many a senior officer, through lack of courage, fails to reprove the junior or to "prefer charges," refusing to listen to his conscience bidding him do his duty, without fear or favor.

Readiness to assume responsibility is thus seen to be a necessity in the naval service, for in this a man frees himself from that position in which his professional life is cramped into the simple certainties of obeying orders.

Orders cannot foresee contingencies. Under contingent peril or approximate evil, administrative and strategic emergencies are to be met and dealt with independently; if a man prove largely adequate to meet them he has arrived at a high professional standard.

(5) There is one supreme test of official responsibility, which does not often occur in a naval officer's career, but which when it comes, tells of what stuff he is made. It is the moral courage which enables a man to go contrary to orders, to act without them, or to supersede them when in his opinion the situation justifies his action.

In the opinion of his superiors, he may be wrong. He may have to suffer bitter consequences, but in the apparent conflict of duties something is due to himself and his position, and perhaps his better knowledge of the circumstances, as the case may be.

Such action is not to be commended in general. It is subversive of discipline. It has disastrous results not infrequently to the individual, and yet it is often of highest value.

The justification of it is success, as in Nelson's case at St.

* "Surtout point de zèle."

Vincent. In the general joy of victory all blame disappears as the smoke of the battle dies away. Sometimes an attitude of insubordinate error is overlooked, as in Hawke's case stationed off the French coast.

The government had sent a squadron under a junior officer, Lord Howe, to operate as a fighting force, while to him came the less conspicuous duty of covering the junior's operations. He complained in a letter to the admiralty, "Now every means to ensure success is provided, another is to reap the credit," and concludes: "I have therefore directed my flag immediately to be struck, and left their Lordships' orders with Vice-Admiral Holburne. For no consequence that can attend my striking it without orders shall ever outbalance with me the wearing it one moment with discredit."

On this act Mahan comments finely. "It is impossible to justify so extreme a step as abandoning one's command without permission, and especially under circumstances that permitted the orderly course of asking for detachment. Nevertheless Hawke did well to be angry; and as is sometimes the case, an injudicious and in point of occasion, unseemly loss of temper, doubtless contributed to insure for him in the future, to a degree which forbearance or mere remonstrance would not have assured, the consideration essential to his duties."

It seem apparent that in the critical moments of a naval officer's professional course there is required of him an extraordinary degree of moral courage.

Shall he himself, at the risk of failure and discredit, undertake the movement not provided for in his orders?

Shall he act independently of his orders, knowing of circumstances which his superiors could not have known when his orders were issued?

Shall he consider the larger view and act as Rodney did when Lord Sandwich complimented him for "taking the great line of considering the King's whole dominions under your care," who left his station at the West Indies in 1780, journeying northward, and ordered Admiral Arbuthnot at Sandy Hook to put himself under his command and obey his instructions.

These are serious questions. They have come to many of the best naval officers of whom biography informs us. As they are answered, so will the degree of a man's moral courage be estimated, and consequently his professional standing.

The various branches of a naval officer's education, the efforts of his ambitions, the activities of his experience—all have but one ultimate goal, the ability to destroy the enemy.

This is his purpose as he achieves command. This continues to be his aim when he attains flag rank. From the beginning of his career until its end this should be the thought uppermost in his mind in way of preparation,—and every honest stroke of work preceding fits him for this final usefulness.

4. STRATEGICAL SKILL.

It is true that only a small percentage in any service ever attain supreme command, but it is necessary that every officer should endeavor to be skilled in strategy, in knowledge of strategical and technical combinations with reference to national conditions.

It must be always premised that there lies at the root of all a naval officer's endeavors the soil of an ardent patriotism. Otherwise he cannot, except as an intellectual exercise, take any interest in the large questions which concern his professional duty.

Raleigh characterized what has always been the aggressive naval policy of Great Britain in his well known sentence. "If we be once driven to the defensive, farewell might." It does not appear, however, that while this has been the political policy of Great Britain, that any systematic effort by way of education has been made to inform the defender of the nation by sea as to the proper methods by which English supremacy shall be maintained. There has not been until recently on either side of the Atlantic a philosophical study of naval strategy, nor until a few years ago, manœuvres at sea. "The van to van, ship to ship dogma" held its own in naval tactics for centuries. When Nelson at Aboukir Bay doubled in his attack, the traditions were all in favor of the customary attack by single vessels. Having once been done, it seemed obviously the thing to do.

There has been a conspicuous lack in professional iniative and effort in these lines of strategy and tactics, as shown in the smallness of the bibliography on these subjects. They are of first importance. Nothing can be known concerning them without a serious and profcund study of history. It is noteworthy that the most renowed of military commanders, Alexander, Napoleon, Wellington, all studied the campaigns of preceding generations

with keen interest. Alexander, his Iliad; Napoleon, the campaigns of Cromwell, and Wellington the large sources of information which were accessible to him.

On the chessboard of nations, the same combinations will again recur as in the past, and the former successful move will again produce the checkmate. It has been said that reason is "the power of using old facts in new circumstances and this is the secret of the production of vast effects with limited resources." Likewise an invention is often the simplest device and the great wonder is that it has never been discovered before, but the result has been produced by constant and profound contemplation of a problem until the soil having been prepared, the thought like a seed falls suddenly into the fertile mind and produces the precious fruit. So it may be in the science of warfare in the future. The new combination resulting from study of all possible conditions, and reinforced by the experience of the past, will prove successful.

The study of the large and last things, the ultimate aim, should engage the profound interest of the naval officer; for these world-wide questions of strategy crown the efforts of his whole career.

In the making of every noble art there is joined the admiration of an ideal and the interest in working it out. Joy in labor is the artist's reward. Every monotonous blow of the sculptor's chisel grows musical to his ears as the statue comes forth in rounded fairness. Wearisome cruising days and nights on watch, the rut of routine, harsh phases of an abnormal life are all lived through complacently if there be within the naval officer a lofty conception of his chosen pursuit.

5. PROFESSIONAL DIGNITY.

He must possess a high idea of the dignity and value of his profession. Otherwise the professional career will prove fruitless as a tree poisoned at the root.

The records of its past must appeal to him, its future possibilities invite him to further attainment, its present needs call forth his closest application.

Professional loyalty must be vital at the centre of his being. Only thus shall he reap the rich reward which comes from the continual glow of interest infusing all his service. The severe labor will become true joy.

There is an epoch in every naval officer's life, who amounts to

anything, when he awakens to the greatness of his profession; henceforth it is no longer a means of livelihood merely, nor simply a position of social distinction, nor is it endurable for him to fatten his professional pride on its historic glories. Now he takes home to himself as a man its large demands upon his student spirit, its usefulness to the land he loves, its responsibilities, the debt he owes to the men who have gone before him, his obligation to the men who follow after,—these things arouse his ambition and determine him to be, all that he would be.

There is a high reward which is given to the naval officer which in itself exalts his profession in its purposes and aims above the ordinary pursuits of men.

A time may come when in the hour of his country's peril to him the inestimable privilege may be bestowed, the great good fortune may fall, in some decisive hour when nations are breathless in suspense awaiting the result, the opportunity by foresight and energy may be given; by devotion and will power, by professional skill, by the might of his manhood, to save his country and to bless mankind. Such was the privilege of Don John, of Austria, when at Lepanto he beat back the barbarous Turk. Such fortune came to Nelson at Trafalgar when the thunders of his "storm beaten frigates" silenced the ominous tread of the immense armies of the great Corsican.

No naval officer who once realizes such a possibility in his career can ever after fail to estimate his profession at the highest value.

It was said of a noted Scotchman that "he loved the harsh voice of duty like a call to battle, he loved courage, enterprise, brave natures, a brave word, an ugly virtue; everything that lifts us above the table where we eat, or the bed we sleep upon." A spirit like unto this, freed from all sordid and selfish aspirations, best fits one for the great emergencies.

After a long life spent in the varied duties of the profession, harassed by its many vicissitudes, and cheered by its occasional successes, a man may consider himself fortunate whether fame come to him or not, thus to have had the opportunity to serve his native land.

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THE EVOLUTION OF SMOKELESS POWDER.

By LIEUTENANT R. W. HENDERSON, U. S. Navy.

Of the hundreds of different mixtures and compounds discovered to have an explosive nature, perhaps the best known are, gun-powder, gun-cotton, nitro-glycerine, dynamite, mixtures of potassium chlorate, picrate compounds, fulminates of mercury, silver, copper, etc., and smokeless powder. However those having no bearing on the development of smokeless powder will not be considered.

Gun-powder is the oldest known explosive, and was first used in warfare as early as the year 1350. It is composed of potassium-nitrate, carbon and sulphur, in proportions of 75%, 13%, and 12% respectively, and these proportions have varied but slightly in its entire history.

Gun-powder is purely a mechanical mixture, the various components being finely pulverized, mixed thoroughly, and the fine dust sifted off. Although affected but little by frost or cold, it is susceptible to fire, and moisture renders it useless. Continued experiments following its discovery showed that the violence of its explosion and the time of its burning could be regulated by caking the powder into grains and pellets, which resulted in its continued use for guns of all descriptions.

The disadvantages of the standard type of gun-powder are very apparent. The bore deposit is considerable, rendering a frequent cleaning of the gun necessary. The smoke arising from the discharge of even a small quantity is excessive, and obscures the vision of the gun's crew for a considerable length of time. When used in small arms by skirmishers or sportsmen, it makes the position of the marksman at once evident. Also the limit of velocity for the different calibred guns was soon reached, and no

forward steps were being made. It was not, however, until the discovery of gun-cotton and nitro-glycerine, that the possibility of obtaining a smokeless powder was considered.

Smokeless explosives, of which gun-cotton and nitro-glycerine are the most important, were first discovered in 1832, by Braconnot, who found that starch dissolved in nitric acid and then washed out with water became highly explosive. Shortly after, Pelouse obtained the same results by using cotton fabrics instead of starch. It was not until 1846, however, that Schonbein succeeded in obtaining a true gun-cotton, from using a mixed bath of nitric and sulphuric acids. This fibrous cotton was seized upon eagerly as a smokeless explosive, and rammed into cases and used with such disastrous results, that it was soon given up. An Austrian, Von Lenk, persisted in trying to overcome the erratic and violent nature of the explosive by regulating the rate of burning, which he did to some extent by braiding together wisps of uniformly dense fibre.

In 1863, he organized the first smokeless explosive battery, consisting of six 12-pdr. guns, and used the explosive with success for a year. Then two large magazines blew up, from unknown causes, and it was abandoned. The English government had watched these experiments carefully, and they were taken up in 1863 by Sir Frederick Abel. In 1865 he published his process of manufacturing gun-cotton, which marked a new era in the history of this explosive. Although improvements have been made in the machinery, the process practically remains the same to-day, and will be considered later.

Nitro-glycerine was discovered in 1847, by Ascagne Sobrero, just one year after the discovery of gun-cotton, but it was not applied as an explosive until 1864. Nitro-glycerine was prepared by the action of a concentrated mixture of nitric and sulphuric acids on glycerine. The result was an oily liquid, colorless, odorless, with a sweet taste, poisonous, specific gravity of 1.6, and highly explosive.

A curious fact may be noted here, that both nitro-glycerine and gun-cotton first found their use in the United States, but not as explosives. In 1847, Dr. Maynard, of Boston, dissolved gun-cotton in ether and alcohol, using the solution, collodion, for surgical purposes. One year later, nitro-glycerine was found to have a great stimulating effect on the heart, if injected in minute quantities, and was so used in medicine.

Nitro-glycerine was at first considered too violent to be used as an explosive, but experiments brought to light the fact that it congeals at 40° F. and while in that condition is practically safe, although it explodes violently by concussion when in an uncongealed state. It was not susceptible to fire, but its rate of explosion, not being under control, presented a serious objection to its use. It was with the use of gun-cotton and nitro-glycerine as bases that nearly all experiments were made in the development of smokeless powder.

A smokeless powder was first offered to the world in 1860 by Col. Schultze of the Prussian army, who put out a semi-smokeless powder consisting of wood fibre cut into grains, purified, nitrated and finally impregnated with potassium nitrate or barium nitrate. This same powder was also manufactured by the American Wood Powder Company, but, when tried in rifles by the United States army, it was found to be worthless.

In 1866, Messrs. Prentice & Co. of Stowmarket, used a felt-like paper compound of gun-cotton and ordinary cotton for a charge, and at the same time Designolle and Brugere, in France, brought out a powder consisting of picrate of potash, saltpetre and charcoal, which was semi-smokeless, and which gave excellent results in the French chassepot rifle. In 1875 Spill patented a production of tubes for soluble and insoluble gun-cotton, and among various solvents he mentions ether and alcohol and nitro-benzine. We have here a forerunner of Prof. Monroe's indurite, which marked the beginning of the successful manufacture of smokeless powder in the United States.

Experiments continued along this line until 1888, when Alfred Nobel, a Swedish engineer, produced an explosive gelatine which resulted one year later in the manufacture of cordite.

In 1889 the first successful work was done by the U. S. Government, and the subsequent development of smokeless powder under the Ordnance Bureau of the navy will now be considered.

EARLY DEVELOPMENT IN THE NAVY.

The first smokeless powder used in the United States was fulminate of mercury, as its gases are practically transparent, and it is used to-day for the cartridges of the Flobert .22 calibre rifle. When tried for larger guns, however, it was entirely too violent, the rate of explosion not being under control.

The first work by the Navy Department began at the naval torpedo station in 1888, when Prof. C. E. Monroe produced indurite. Indurite is military gun-cotton purified by extraction with methyl alcohol, dried, gelatinized by mono-nitro-benzine, mixed, rolled, blocked, pressed and dried, after which it was placed in boiling water to remove the solvent. It was then cut into macaroni forms or flakes, depending upon the requirements. This powder was tried succesfully, but was not adopted by the service, pending further development.

Various experiments were carried along, but the most important was a general analysis of all the gun-cotton on hand, which showed a great variation in the percentage of nitrogen. This proved that the texture of the cotton, the weather, the time of nitration, and a slight variation in the temperature or strength of the acid, all affected the final percentage of nitrogen.

In 1894, nitro-benzine as a solvent was replaced by acetic ether, and camphor was added as a deterrent.

The most important changes came in 1895, when Lieut. Bernadou and Prof. Brown began to blend the various lots of cotton to obtain a fixed percentage of nitrogen.

Acetic ether was replaced by acetone; selected lots of cotton were taken with reference to nitrogen; these were blended and barium and potassium nitrates and a precipitate of chalk were added to the blend to furnish oxygen. Camphor was omitted on account of its volatility.

It was then noticed that this acetone powder was very brittle, while the French powders were correspondingly tough. Acetone was then replaced by ether and alcohol as a solvent, and the result was that a much tougher powder was obtained. The next steps were in experimenting with nitro-cellulose and the method of purification and it was found that a soluble nitro-cellulose, containing as high as 12.8% of nitrogen, could be readily obtained.

Troisdorf powder had been found to be excellent, using nitrogen from 12.5% to 13% and using 2 parts of ether to one part of alcohol as a solvent. Barium nitrate was tried in the ether and alcohol solvent, but as it gave rise to smoke it was gradually reduced and finally done away with.

Prof. Mendeleef, (Russian), produced a pyro-collodion, the properties of which were:

1. Nitrogen uniform, and at 12.44 per cent.

2. Solvent: 3 parts ethyl alcohol; 1 part ethyl ether.

3. Heat test raised by washing with alcohol.

Lieut. Bernadou and Prof. Brown then experimented in making a powder on these lines.

A mixed acid was used, containing about 57% sulphuric, and about 28% nitric acids, the remaining 15% being water.

The initial temperature was atmospheric, the final about 40° C. secured by placing the nitrating pots in hot water. These were turned at the end of 35 minutes, making the total time of nitration 70 minutes. The cotton was then cooled and purified by Abel's method. The heat tests, however, came too low, only about ten minutes being obtained.

From this time forth, however, it was merely a question of perfecting the process, and this was done in the face of considerable opposition.

The pots were no longer turned; the time of nitration was gradually reduced to 60 minutes, then to 45 minutes, and finally to 30 minutes; a method was devised for utilizing the spent acid, materially decreasing the cost of manufacture; the duration of washing was diminished; and by increasing the proportion of mixed acid to the cotton, an increase of nitrogen-tetroxide, which causes fuming off, was avoided.

This leads up gradually to the process of manufacture of smokeless powder in use at the present day, which will be considered in detail.

MANUFACTURE.

The base of navy smokeless powder being gun-cotton, it is essential to first consider its manufacture, before proceeding with that of the powder.

The base of gun-cotton is pure cotton fibre, and this is usually obtained from white machined cop-waste.

It is possible to purify this waste in the factory, but at the present time there are several firms that purify cotton waste especially for the manufacture of gun-cotton, and it now proves just as cheap to buy the waste directly from these firms. It is furnished in bales of from 50 to 200 pounds.

PICKING AND DRYING.

This is a preliminary step to nitration. The cotton is extracted from a bale by hand, and then sent through a cotton picker. This

picker consists of two iron rolls, revolving at a distance of about two inches from each other. On each roll are projecting teeth that pass just clear of each other as the roll revolves.

As the cotton is fed through the rolls it is torn and shredded between the teeth, thus separating the fibre and exposing a greater surface to nitration. The cotton is then spread out in trays and placed in an oven for drying. The capacity of these ovens varies from 50 to 100 pounds. This drying drives off any impurities and small particles that may remain in the fibre, and renders it more susceptible to nitration. The cotton is allowed to remain in the ovens for four hours with the temperature 100° F. and is then placed into air tight tanks and removed to the nitrating house.

NITRATION.

There are two general systems of nitration—the pot system and that of the nitrating centrifugal. As the pot system is more expensive, and very susceptible to fires, it is not regarded with favor, and only the nitrating centrifugal will be considered.

In this system 16 pounds of cotton are usually dipped at a time, (this quantity depending upon the size of the machine used), into a solution of concentrated nitric and sulphuric acids. The strength of this mixed acid varies with the percentage of nitrogen desired. To obtain a cotton having from 12.4 to 12.8 per cent. of nitrogen, the strength of the acid is: sulphuric, about 56.5%; and nitric, about 28.2%, the remainder being water. The weight of the acid used for 16 pounds of cotton is 900 pounds.

At most powder works the average time of nitration varies between 25 and 35 minutes, depending upon the dampness of the atmosphere. The acid solution is kept at a temperature of 30° C. Great care must be taken not to exceed this temperature more than one or two degrees, otherwise there will be a fume off, the nitric acid breaking down and giving off reddish brown fumes. In case this heat is generated by the action of a drop of moisture on the sulphuric acid, it can be reduced by at once forking the heated portion under the surface of the solution. Care must be taken that no moisture falls upon the cotton after the acid has been wrung off, and before the charge has been removed to the drowning tank, for this will usually result in a fume off, and the 16 pounds of cotton will be reduced to a worthless charred mass.

An earthenware flue and an exhaust fan carry off the fumes arising from the ordinary process of nitration.

At the International Powder Works, the time of nitration has been reduced to 15 minutes. This is done by increasing the strength of the nitric acid, but as the danger of fuming off is somewhat increased, unless great care is observed, the time gained is lost.

After the charge has been nitrated the acid is wrung off by means of revolving the centrifugal, and the cotton is forked over into a drowning tank, where some of the free acid is drowned out; after which the cotton is placed into wringer and wrung out, while a hose assists in washing away the exposed free acid. The cotton is then placed into bins until a sufficient quantity is ready for boiling.

The succeeding steps, boiling, pulping and poaching, are merely steps for the purification of the nitrated cotton, to get rid of all particles of free acid and impurities, in order to make the heat test as high as possible.

BOILING.

As the capacity of the pulper, usually about 500 pounds, is a convenient unit for a lot of pyro-cellulose, two boiling tubs should be used each holding 500 pounds. These tubs should be fitted with feed and drain pipes for water, and also a steam pipe for heating. A flue should be fitted from the top of the tubs to carry off the vapor.

The cotton is boiled for three periods of two hours each, at 100° C. the water being changed at the end of each two hours. Fresh cold water is then run in and drained off, washing the cotton, which is then transported to the pulping house in cars.

PULPING.

In pulping, the cotton is placed in cold water, and forced by means of paddles, to pass between moving knife blades which cut and shred the cotton, thus rendering it possible to wash out any of the impurities that may remain within the fibre itself.

The process of pulping takes from 5 to 15 hours, depending upon the texture of the cotton and the steam pressure, and the only way to tell when the charge is sufficiently pulped is by handling it. An experienced man can tell at once by the feel of the cotton if it has been properly divided and chopped up.

During the pulping the solution should be kept alkaline by the addition of soda. The water should be constantly changing. A pump, fitted with a washer of brass wire to prevent the cotton getting through, can draw off the surface water, which is replaced by fresh feed water on the opposite side of the pulper. After the pulping is complete, the charge is run by gravity to the poachers.

POACHING.

The poaching tubs should have the same capacity as the pulper, i. e., 500 pounds. In these tubs a paddle or a propellor, driven by a small engine, constantly agitates the cotton and water, which mixture is kept at the boiling point. As the cotton is heavy and sinks to the bottom of the tub, a propellor at the bottom, driven by a vertical shaft, will be found preferable to Abel's side wheel paddle, which does not thoroughly agitate the bottom of the pulp. The poaching covers a period of 12 hours in boiling water, but experiment has shown that better results are obtained by subdividing this 12 hours, and washing the cotton with cold water between the divisions.

Different sub-divisions are used at the various factories, but seemingly the best results have been obtained by using periods of 6 hours, 3 hours, and 3 hours duration, with 3 washings of cold water between periods. At the end, the charge is given 12 washings with cold water, after which it is given the test for stability. The charge is allowed to remain in the poacher until the stability test has been completed, because, if it fails to meet the requirements, the lot must be retreated.

STABILITY TEST.

To make this test, the pulp is skimmed with an agate dipper and sent to the labratory in a quart bottle. Here it is poured into a piece of clean cheese cloth, and put into a small fruit press where as much water as possible is squeezed out.

The remaining cake of cotton is then broken up by hand and put on a paper tray, and placed in a drying oven, where it is heated from 5 to 6 hours at 43° C. It is then taken out and allowed to stand in the air to take on moisture, from 1.5 to 2% being desired. Twenty grains are then weighed out and placed in a test tube 5½ inches long, and ⅝ inches in diameter. The pyro is then pressed down in the tube to occupy a space of about 1⅝ inches;

and the remaining dust and particles removed from the sides of the tube.

A strip of potassium-iodide-starch paper, 1 inch by ⅜ inches is then moistened by a drop of glycerine solution, and suspended in the tube by a platinum hook. The tube is then inserted in a bath heated to 65.5° C.

The required stability test is 30 minutes, but it is very advantageous to exceed this by 5 minutes is possible.

When the pyro decomposes, a dark brown line is formed at the junction of the moistened and dried portions of the test paper. The action is as follows:

HNO_2 is liberated by the heat. $KI + HNO_2 = KNO_2 +$ HI.

But as the hydroiodic acid (HI) is unstable, it breaks up further liberating iodine.

$2HI + O = H_2O + I_2$.

The free iodine then unites with the starch making the brown line. This last is not a chemical reaction and its formula is not known. If this line appears before 30 minutes after the tube was inserted in the bath, the test fails and the lot must be repoached.

If the time exceeds 30 minutes the test is successful. In case a number of drops of moisture collect on the sides of the tube, the pyro has too much moisture in it and the test is useless. In this case the pyro must be redried.

WRINGING.

After the stability test is successful, the cotton is allowed to run by gravity directly into a centrifugal wringer, which revolves at a very high rate of speed, and the cotton is wrung out as dry as possible. After this wringing it contains about 25 to 30% of moisture, and is then placed into boxes ready for dehydration, the preliminary step to the manufacture of the powder.

DEHYDRATION.

As stated, after leaving the centrifugal wringer the cotton contains from 25% to 30% of moisture, and in the manufacture of smokeless powder it is necessary to drive out this moisture and replace it by the solvent. A dehydrating press is used to accomplish this.

A charge of 44 pounds is weighed out, which is equivalent to

about 33 pounds of dry pyro. The press is provided with two pistons, the head being grooved in the lower one to permit the water to escape. The lower piston is run up, the charge is placed in the cylinder, and the upper piston is run down at a pressure of 200 pounds per square inch.

Alcohol, equal in weight to the weight of the dry pyro, is then run in on top, an air cap is placed on the top of the cylinder and held down by the upper piston, and the alcohol is forced through the cotton by means of air pressure at about 100 pounds per square inch. The dividing line between the alcohol and water can be readily told, and the pure alcohol saved. A distilling plant recovers the dilute alcohol.

The cap is then taken off the cylinder and the whole mass of cotton subjected for about two minutes to a pressure of 2000 pounds per square inch. The resulting block is then taken from the cylinder and contains about 25% of alcohol, and less than 5% of water. As our formula for colloiding is 1 part of alcohol to 2 parts of ether, it becomes necessary to only add ether equal to half the weight of the block, and the pyro is ready for mixing.

MANUFACTURE OF POWDER.

As the subsequent steps in the manufacture of powder are of short duration, and require but little description, they will be considered as a whole rather than singly.

The block of pyro, containing about 25% of alcohol, is taken to the mixing room and broken up by hand into the mixer; and 50% of ether is then added. The whole mass is then thoroughly mixed and pulped by means of two revolving cork screws, which turn in opposite directions. This is continued for from 1½ to 2 hours, the direction of turning of the screws being frequently reversed, until the whole mass is thoroughly mixed. It should then be soft and mealy to the feel.

It is then taken out and run through the strainer press to remove any small hard lumps that may remain after mixing.

It may be noted here that sometimes the mixings are so clear that no straining whatever is required, while at other times the same brand of cotton shows many lumps, and straining is absolutely necessary. This can be accounted for solely by a difference in the texture of the cotton fibre.

After straining, the pulp is taken in tanks to the block or mould-

ing presses, where it is pressed into cylindrical blocks about 6 inches long and 3.5 inches in diameter.

These in turn are taken to the die press room, and run through dies depending upon the calibre of the powder desired.

Flat ribbons are run out for flake powder, and circular multi-perforated cords for all powder higher than one-pounder.

These cords are cut off in suitable lengths by the press boys, while the ribbon powder is rolled up on reels. The powder is then cut as desired by an automatic chopper.

After cutting, the multi-perforated powder is ready to be put in the dry house at once; but the flake powder must first be sifted and dusted, due to the fine dust and imperfect flakes that collect in it.

The powder is then transported to the dry houses, where it is spread out on trays to dry. The dry houses are kept at a temperature of from 95° to 105° F. but the time of drying depends to a large extent upon the weather.

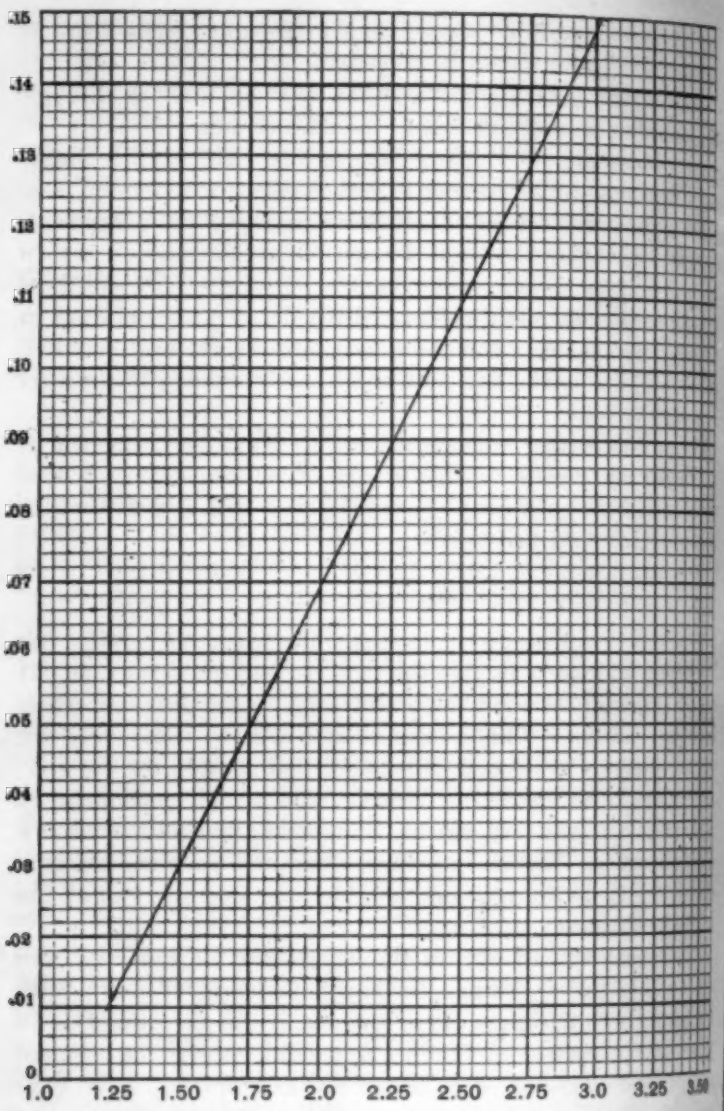
TEST FOR VOLATILES.

It now becomes necessary to determine when the powder has been dried sufficiently to give the required ballistic results, as this drying is one of the most important steps in the development of smokeless powder. The powder must not be so excessively dry that the pressure developed will exceed that allowed for the gun; nor, on the other hand, can it have such a high percentage of volatiles that it will dry out on board ship, and thus become a quicker powder. The mean between these two positions has only been determined after a careful consideration and study of all the accumulated ballistic data.

Experiment has shown us the maximum thickness of web which will be entirely burned, for any given length of gun. With this known web thickness of the powder, it was then dried down to as low a percentage of volatiles as possible to give the required velocity and pressure, and numerous experiments soon gave sufficient data to construct a curve which would show at once the total volatiles necessary to give the ballistic requirements.

This will be seen from the portion of the curve shown—the ordinates representing the web thickness, the abscissæ total volatiles, and the curve the required ballistic result.

Once determined by experiment, the thickness of web to be entirely consumed can be calculated for any powder as follows:



Total volatiles to be obtained in dry house.

The thickness of web is given for comparison: $T = \frac{D - 3d}{4}$

T = Thickness of web.
D = Diameter of grain.
d = Diameter of perforations.

For grains of 7 perforations: $T = \frac{D - 3d}{4} + \frac{D}{10}$

For grains of 1 perforation: $T = \frac{D - d}{4}$

For flake powder T = Thickness of strip.

To determine the percentage of volatiles.

After the powder has dried down for about the length of time deemed sufficient, a sample is taken from the lot and sent to the laboratory for test. This is cut into slices about .02 inches thick, and a known weight is placed in a glass dessicator, in the bottom of which is calcium-chloride,—CA CL_2. It is allowed to remain here for 48 hours and is then taken out and reweighed. The loss of weight is considered moisture. Usually about 2.5 grammes is taken for this test.

The remaining powder, after the loss of moisture, is then placed in a drying oven and heated for 5 hours at 80° C. and the new loss of weight is considered solvent.

The total loss of weight from the moisture and solvent is the total volatiles of the powder.

In case it is desired to obtain the total volatiles approximately the powder is not placed in a dessicator, but is placed in the drying oven at once and heated for 5 hours at 80° C.

Sufficient moisture is driven off by this drying that the total loss of weight can be considered as the approximate total volatiles.

The precipitation method is another way of obtaining the total volatiles. This method requires time and constant attention and as its results are not any more accurate than the above method, it is seldom used.

In this method, a certain known weight of powder is disolved in ether and alcohol, the solution poured into water. The ether and alcohol start to escape, and can be readily boiled off. The residue is then dried down and carefully reweighed.

The loss of weight is considered the total volatiles.

BALLISTIC TEST.

After the powder has been dried down to the percentage of volatiles desired, a firing sample is taken out, and the remainder is taken to the magazine and stored in air tight boxes marked with the number of the lot. The firing sample is taken to the firing range for ballistic test.

Assuming the case of 6-pdr. powder,—the ballistic requirements are: 2250 feet per second in velocity, and the pressure not to exceed 13.5 tons. The charge, owing to the capacity of the cartridge case, cannot exceed 610 grammes, but the less powder required the better. The velocity is obtained by means of a set of firing screens and a chronograph; the pressure being obtained by a pressure gauge and disc, which is placed in the cartridge case at the base when the charge is made up. Chronograph tables and a pressure curve enable us to get the result from the test.

At least three shots should be fired, starting with a small charge and increasing it until the required ballistic result is obtained. If the requirements are fulfilled the powder is accepted and the lot is put aside for the general blend. If the velocity falls short for a charge of 610 grammes, it is usually found that the powder is not dry enough, and the lot is placed in the dry house and dried down to a lower per cent of volatiles and tried again.

If the pressure exceeds 13.5 tons, as it frequently does in powders of high nitrogen, it is usually on account of excessive dryness. It has been found that in the presence of moisture the pressure falls much faster than the velocity, and the best way known at present to reduce the pressure is to allow the powder to take on a small per cent of moisture.

Of late, however, the bureau is discouraging this practice, as they are requiring very dry powders, due to reports that powders frequently dry out on board ship and so cause higher pressures than those obtained when the powder was tested.

This necessitates a quick burning powder with a low nitrogen, and still one that will give the required velocity. This is not an easy thing to obtain, and it can only be done by exercising great care with the web thickness in manufacture, and also with the total volatiles obtained in the dry house.

BLENDING.

When sufficient powder is assembled, a general blend is made so that the entire lot will be uniform. Boxes from each lot are opened and a like amount taken from each and placed in a cylindrical blender. A few turns of this is sufficient to thoroughly mix the lot, and it is then taken out and stored permanently in the new standard powder boxes ready for shipment.

It is well to have the two ends of the blending cylinder con-

nected to the earth by a copper wire, for in turning, the grains in running over each other generate a certain amount of static electricity, which in some cases has been sufficient to cause an explosion. After the blend has been completed, an index number is assigned to it by the bureau and it is then shipped to one of the naval powder magazines where it is kept until ready for issue to the service as needed.

HEAT TEST OF SMOKELESS POWDER.

In the heat test of smokeless powder there is a preliminary test for powder that has been stored in magazines, which will give an idea as to whether or not the powder is starting to decompose. This preliminary test is embodied in bureau of ordnance letter No. 9928 of December 13, 1902.

Small samples of the different powders stored in magazines are kept in glass bottles and a piece of litmus paper is kept in each bottle. This litmus paper is changed every week and inspected twice daily, and will show any special signs of decomposition. In the preliminary test the sample of powder in the whole grain is placed in a glass stoppered bottle, one day before the regular test is to be made. This is tested by placing a strip of potassium iodide paper, 2 inches by 1 inch, moistened with a large drop of glycerine solution, about the size of a cent. This is kept in the bottle for a period of one hour, and no signs of discoloration should show on the paper.

In the regular heat test, flake powder is not cut. Strip or multiperforated powder is cut into shavings about .002 inches thick and these are put on watch glasses and placed in a drying oven and dried for 48 hours at a temperature not exceeding 43° C. The sample is then exposed to the air until sufficient moisture is taken on for the test: over night will be sufficient. Twenty grains are then weighed out and placed in a test tube. The remainder of the test is similar to the test for pyro-cellulose. The sides of the tube are rubbed clean; a strip of potassium iodide paper fastened to a platinum hook is then moistened with a drop of glycerine solution and inserted into the tube. The bath is kept at a constant temperature of 65.5° C. and the time of insertion is noted. The line of demarkation between the wet and dry portions of the paper is kept even with the line of moisture that will appear on the inside of the tube. If the least brownish discoloration appears at the

line of demarcation the time is noted at once. If no discoloration appears at the end of 40 minutes, the test is discontinued and marked 40 minutes plus. Care should be taken to conduct the test where as good a light as is obtainable will show on the paper. The minimum test that is allowed for smokeless powder is 40 minutes at 65.5° C.

PREPARATION OF TEST PAPER AND GLYCERINE SOLUTION.

In the preparation of potassium-iodide-starch paper, especially pure filter paper is washed with distilled water and dried. It is then cut into strips 6 inches to 8 inches wide and dipped into a solution of potassium-iodide and starch for about 8 to 10 seconds, and then hung up to dry in the dark. Light affects the chemical properties of the paper if exposed for any great length of time.

The solution of potassium-iodide and starch is made as follows: 15 grains of potassium-iodide is disolved in 8 ounces of water, 45 grains of corn-starch is stirred up in water and boiled. The two solutions are then mixed and allowed to cool. The glycerine solution in the heat test is made of equal parts of chemically pure glycerine and distilled water.

Heat test outfits, containing all the necessary apparatus for conducting the test, and a drying oven, are furnished by the torpedo station to all navy yards and to all vessels in the service.

MANUFACTURE OF GUN-COTTON AND FULMINATE OF MERCURY.

A word might be said here as to the manufacture of gun-cotton and fulminate of mercury, as both come under the class of smokeless explosives.

The manufacture of gun-cotton differs but slightly from the manufacture of pyro-cellulose as already explained. The principal difference is in the strength of the acid used.

A cold mixed acid of about 70° F. is used, and the percentages are: about 73% of H_2SO; about 22% HNO_3; and about 5% H_2O. The cotton is nitrated in this solution for about 24 hours, and was formerly done by the pot system, although the nitrating centrifugal is now used. The purification process and the stability test are exactly the same as for pyro-cellulose.

After the stability test the pulp is not wrung out, but is run from the poacher into a small tank and stirred up with a screw paddle. A mixture of pulp and water is then run into a prelimi-

nary press and subjected to a pressure of 100 to 200 pounds per square inch. This gives a block of about 60% moisture. This block is taken to a final press and subjected to a pressure of about 2000 pounds per square inch and when taken out contains about 14 to 15 per cent moisture. The block is then put into a pail of water and allowed to increase in weight until it contains about 25 per cent moisture, which is the navy standard. The completed gun-cotton contains from 13.1% to 13.5% of nitrogen.

A die in the final press stamps on the block the place and date of manufacture, and the number of the lot, so that a history of the cotton can be kept and if any one part shows signs of decomposition, the whole lot can be traced and destroyed.

Wet gun-cotton is exploded by means of dry gun-cotton; by a sympathetic explosion of one part of wet gun-cotton near another, and occasionally by the explosion of dynamite in the vicinity, although gun-cotton explosion will not detonate dynamite. Wet gun-cotton is regarded as the safest explosive known.

FULMINATE OF MERCURY.

Fulminate of mercury is perhaps the most dangerous explosive known. In its manufacture, nitric acid is reduced by the addition of water to a specific gravity of 1.37.

One part of mercury by weight is dissolved in 12 parts of nitric acid by weight. When dissolved this is put into a lukewarm solution of 11 parts of alcohol and allowed to act.

Bubbles of gas are given off, together with white fumes which eventually turn red. As the action is completed, the fulminate settles to the bottom as a greyish black powder precipitate.

The solution, precipitate and all, is poured into a large vessel and washed repeatedly with water until no acid reaction is obtained. It is then stored away for use, the fulminate being kept under water. In winter a bit of alcohol is added to keep the solution from freezing.

Fulminate of mercury is exploded by means of percussion, by heat, and by strong sulphuric acid. Thirty-five grains are used in a detonator or exploder, and about .4 grains is put into a primer cap. In loading an exploder or detonator, the fulminate is first removed from water and dried in a steam oven of 40° C. for a period of from five to seven days until thoroughly dry, and then loaded into the fulminate case.

SPECIAL REGULATIONS FOR SMOKELESS POWDER.

Special rules for the care of smokeless powder on board ship and in magazines have been issued by the department.

These rules are of sufficient importance to be noted.

1. A sample of each lot of accepted powder is kept in the factory, and frequently observed and tested. The bureau is informed at once of any deterioration.

2. A sample of each lot of powder in the magazine is given the prescribed heat test once every 3 months.

3. All smokeless powder is to be stored away from the direct rays of the sun.

4. Samples of each lot are to be kept in glass stoppered bottles and inspected twice daily.

5. All magazines are to be inspected twice daily.

6. No fixed ammunition containing fulminate primers is to be stored in any smokeless powder magazine.

7. Black powder must not be stored in the same magazine with brown or smokeless powder, except where it forms the ignition charge of prepared ammunition.

8. No oakum, waste, rags or any oily matter are to be allowed in a smokeless powder magazine or loading room.

9. Gun-cotton should never be stored near smokeless powder.

SUMMARY AND DISCUSSION.

It remains to discuss the existing conditions of smokeless powder in our service, for too much cannot be said in its favor, and against those who have done so much to hinder its advancement. Its advantages are most apparent, and it seems as essential to provide the gun captain with an unobscured vision in firing as it is to provide him with modern ordnance. The extra cost in the manufacture of smokeless powder is practically made up in that a much less charge of it is needed to give the required ballistic results.

For the small arm, its greatest advantage, aside from the higher velocities obtained, is that is does not disclose the position of the marksman, a thing invaluable to the scout and skirmisher. As for its use in rapid fire guns and guns of larger calibre, how well will it be recalled in the Santiago blockade and bombardments the necessity of waiting frequently for 2 or 3 minutes until the dense clouds of smoke were blown away. And with what

envy did we look upon the New Orleans, as she fired continuously, with no interruptions on the account of smoke.

A word may be said here in connection with the recent mishap to the Iowa's 12-inch gun. To those interested in the future welfare of smokeless powder it seems incredible that this accident should have been laid to the smokeless powder charge.

If a rubber band is guaranteed to be stretched to its elastic limit 100 times, and it is stretched 200 times and breaks on the 201st stretching, fault can hardly be found with the stretching agent. Yet this is exactly what was done in the case of the Iowa's gun. That unequal pressure waves were developed in the bore by the explosion of the charge is something of which no one can be even reasonably certain, and no satisfactory evidence can be shown to that end. Similar charges of the same powder will develope an almost constant pressure ninety-nine times out of a hundred

How very much more probable then, that the gun, having been used far beyond its allotted life of usefulness, developed a weak spot and burst of its own weakness.

Smokeless powder is no longer an experiment but an accom plished fact, and its rate of burning and the pressure developed are under absolute control.

To its disadvantage it may be said that it requires great care in preservation, but care should always be taken in the handling of explosives. Especial care is necessary in making the heat test and the directions accompanying each outfit should be carried out to the letter.

Shortly after the destruction of a large quantity of smokeless powder on board the U. S. S. Olympia, a series of experiments was conducted under my observation with the view of showing that the powder in question might not have been in actual state of decomposition.

The potassium-iodide-starch paper, when moistened with the drop of glycerine solution, will show a slight but distinctively noticeable brownish line when acted upon by alcohol vapor. As the total volatiles of powder seldom goes below 1.5 under service conditions, this will include a small portion of the alcohol solvent, and unless the directions for drying the sample for 48 hours at 43° C. are carefully carried out there is a good possibility that a small portion of the solvent may remain in the powder. When

inserted in the bath at 65.5° C. this remaining solvent will be driven off almost immediately, and the alcohol vapor acting on the test paper will give a slight brownish line, and cause those who are unfamiliar with the test to assume that the powder is decomposing. By taking the cork from the tube these alcohol fumes can be detected at once by their odor, and this should dispel any doubts. The brown line due to decomposing powder is much more distinct than that made by alcohol vapor, but their similarity is sufficient to necessitate great care in making the test, and too much experience cannot be obtained.

It would be a most excellent plan, and a very profitable one to the navy department, *if every ordnance officer in the service was given a special powder course of instruction at the torpedo station before being assigned to ordnance duty on board ship.* With smokeless powder plants at Indian Head and the torpedo station, officers sent to these places would have an excellent opportunity of becoming familiar with its manufacture and care.

There is much room for improvement and advancement in the process of manufacture, and the quality of the powder resulting, but the advantages of smokeless powder are so great that the extra care required with it is not worthy of consideration, and we can but hope that its progress in the future will be even greater than that of the past.

With this object in view, the unceasing efforts of the officers engaged in the development of smokeless powder should meet with the greatest encouragement from the entire service, and the time will soon arrive when we can point with pride to the U. S. Navy smokeless powder as being without an equal as an explosive for modern ordnance.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

COAL CONSUMPTION ON WARSHIPS.

By Lieut.-Commander W. F. Worthington, U. S. N.

In the days of auxiliary steam power on warships, the amount of coal used in port and at sea was small. Only a small amount was used for distilling drinking water and for heating ship in port, while at sea a small additional amount was used for the main engines, the greatest variation of the speed being from six knots to ten knots. The coal consumption at the latter speed being about double that at the former speed. The daily expenditure could be determined with comparative ease and any unusual excess or deficiency could be quickly traced to its source.

At the present time the number of available auxiliary machines is far greater than formerly, and the number in use at any one time continually changing from day to day and even from hour to hour. The amount of fresh water distilled has increased enormously, causing large variations in the expenditure of coal when the evaporators are started and stopped. The speed of a warship varies often from seven knots to nineteen knots. The coal consumption at the latter speed being about ten times that at the former speed. It is no longer possible for a chief engineer to judge at any given time whether or not the amount of coal entered by the machinist on watch in the column of the log each hour is, or is not, correct. He cannot rely on the reports made by the water tenders as to the number of buckets used, if the ship is so large that one water tender has to tend water in two different fire-rooms communicating by only a small door. In such cases the water tender necessarily relies on the coal passers, among whom are always a certain proportion of very careless and thoughtless individuals. As the speed increases, the number of buckets re-

quired per hour increases, so that the coal passers are in such cases still less likely to turn in a correct account. If the water tender is accused of failing to turn in all the coal, he will simply add to his account the number of buckets he thinks will give satisfaction. The writer has known as much as ten tons per day to be thus added for four or five days in succession when the actual amount used was 117 tons, i. e. an excess of about 9 per cent. The chief engineer cannot tell from the records of the logs of other ships of the same class what his own ship should use, for he cannot tell how much to allow for each of the numerous variable circumstances and conditions hereafter to be referred to in detail, some of which would be mentioned in the log, and others perhaps omitted or noted in too vague a manner to be useful. The speed given in the engine log is generally that of the patent log, copied day by day from the deck log, without any subsequent correction which may be made by the navigator at the end of the run. The force of the wind is generally estimated by the officer of the deck. Only a few ships are fitted with anemometers, and no note is made in the engine logs to say by which method the force was obtained, and no data is available on which to base an opinion as to the effect of this wind on the ship. The terms used in the log to note the kind of sea are vague, and subject to vary according to the views of each observer.

It is futile to plot a coal consumption curve by simply taking the data as it comes in the log and running a fair curve through the middle of this group of points.

The practice in the navy is to assume that a certain number of revolutions and a certain number of boilers will be most satisfactory and to generally steam at that speed. A head wind and sea will cause the ship to be slowed down, the number of boilers in use will remain the same, and possibly the bleeder will be opened from time to time and the evaporators run at increased pressure to keep down steam. The coal consumption and speed being plotted on the curve, give a totally incorrect point. On the other hand, exceptionally favorable circumstances will give a ship from one to one-and-a-half knots extra speed, and if this data is plotted in with the rest, another error will go on record. As a rule, slow runs are made when the bottom is foul or the coal poor, and faster runs when the bottom is clean or the coal good. The consequent probability then is, that a group of points ob-

tained from the log to give the average coal consumption at low speeds, would show the average coal consumption at that speed with partly foul bottom and unfavorable weather or poor coal, while the group of points obtained to give the higher speeds would show the average coal consumption at that higher speed with clean bottom and exceptionally favorable weather and other conditions. Furthermore, the instructions in the steam log require that when an error in the coal account is discovered, a per cent correction is to be worked out and applied equally to all the entries in the coal column extending back to the date of previous correction. Since the probability of error in the account increases rapidly with the increase in the number of buckets taken out per hour, the correction should more properly be applied almost exclusively to that part of the record covering the abnormally high speed, at which time the coal passers are busy and more apt to make miscounts.

A curve plotted from the data in the steam log would be likely to give too high coal consumption at low speeds and too low expenditure at high speeds.

The practical question to be answered is not "what amount of coal is, on an average, generally necessary to make a given speed," but, "what amount of coal of some standard quality will be necessary to make a given speed with a known condition of the bottom, an estimated condition of weather on a certain proposed voyage, starting with a known amount of coal." In war time the question would be in the case of a vessel at a distance ordered to join a fleet, "what speed could she afford to attempt to make between the coaling stations located at different known distances apart en route." An under-estimate of the expected daily consumption would cause the start to be made with too many boilers, and necessitate a reduction of the speed after a few days, if indeed the fact of the high coal consumption were discovered so soon. An over-estimate of the daily consumption would cause the start to be made at an unnecessarily slow speed, which might result in the vessel arriving too late at the scene of action.

When a number of ships of the same type are cruising together the wide discrepancies observed in their noon coal reports signalled to the flagship give occasion for considerable comment, and the question arises as to whether or not these discrepancies are due to lack of knowledge of the actual amount of coal used, or

whether they are due to defects in the machinery and ship, or bad management on the part of the officers and men.

Whatever the cause may be, it is obvious that a remedy should be found.

The rational method of proceeding is to follow out the various channels, great and small, through which the coal disappears, and to discover by careful tests, as accurately as possible, how much must necessarily go through each to produce the required results, under the conditions which exist at the time in question.

The general principle to be borne in mind, is that there must always be rendered a "quid pro quo." Light, heat, fresh air, fresh and salt water, clean decks, high speed, every necessity, comfort, convenience and luxury must be paid for in coal. There is never a possibility of getting something for nothing.

IN PORT.

The principal channels through which the coal flows away and the amount which on a modern battleship of 13,000 tons displacement usually goes through each per day are about as given in Table I.

TABLE I.

	Tons	Lbs.
(a) Galley		530
(b) Electric lights, one dynamo, eight ventilating blowers, one feed pump, and radiation from one single end Scotch boiler (⅛th total boilers) and all auxiliary steam pipes	7	1490
(c) Distilling water for drinking, cooking and washing for crew of 700 officers and men	2	1310
(d) Make up feed for two single end boilers (⅛ total boilers) required for port service, steam to heat water in pantry and baths; and for ejectors to pump out drainage tanks.	1	1360
(e) Admiral's barge and two steam launches		1170
(f) One two-ton ice machine, two flushing pumps and one auxiliary air and circulating pump in constant use and two fire pumps on every morning watch for washing decks, and two bilge pumps and one ash hoist engine for a short time on the morning watch	1	1950
Total	14	1120

The methods by which the quantities in the table were determined are as follows:

(a) Coal for the galley by weighing and counting buckets for 23 days.

(b) Average daily expenditure for 33 days, during which time the ship was in drydock, with only the auxiliaries noted in the table in use, and exhausting into the atmosphere. The greater part of the exhaust steam condensed in the long line of exhaust pipe and returned through the drains to the feed tank giving hot feed water. The amount which these auxiliaries would require when exhausting into the auxiliary condenser would be somewhat less, due to the vacuum, 10" usually carried, but on the other hand, somewhat more, due to the steam required to run the auxiliary air and circulating pump. It will be sufficiently accurate to take it at $7\frac{1490}{2240}$ tons. The writer's belief in the accuracy of the tally is based on the fact that the quantity used, 7 to 8 buckets per hour, was so small that a mistake would not be likely to occur. That when the watches changed week after week the amounts reported did not vary much. Also when the ship was docked again, eight months later, the amounts reported were again the same.

(c) Distilling drinking, cooking and washing water for a crew of 700 men (3500 gallons per day), obtained by observation at intervals extending over about a year, when running one evaporator at a standard pressure and for this purpose only.

(d) Make up feed for the two boilers used in port, and steam to heat water in the pantries and baths, and pump out drainage tanks by ejectors, was obtained by measuring feed tanks daily for six weeks and assuming that one ton of coal will produce five tons of distilled water.

(e) Admiral's barge and two steam launches, obtained by observation extending over a period of 49 days, when the boats were doing normal service.

(f) One two-ton ice machine, two flushing pumps, and one auxiliary air and circulating pump in constant use, and two fire pumps used every day on the morning watch for washing decks, one ash hoist engine and two boat cranes and two bilge pumps at intervals. This was obtained by taking the average total daily consumption obtained accurately for a period of seven weeks, and found to be 14.5 tons per day. Then subtracting the quantities, *a*, *b*, *c*, *d*, and *e* from it.

The daily expenditure is sometimes reduced by using pulling boats in place of launches, and by stopping both evaporators for a part of a day when they need scaling or when the ship's tanks

are full. The amount given in the table is increased at times by distilling a large amount of extra water to fill up boilers after they have been cleaned, to make up losses caused by leaks starting in boilers, to scrub paint work after coaling ship. It is also noticed that an extra amount is required when the men scrub hammocks, and when the crew wear white in the tropics. Not unfrequently a large waste of fresh water occurs in the various pantries, sometimes in one, sometimes in another, and in the bath-rooms, due to the carelessness of an attendant in leaving a cock open or allowing the storage tanks to overflow.

The quantities in the table were determined in temperate weather and when the days were of about average length. In winter a small additional amount would be required for steam heat and in summer for running the complete outfit of electric fans and blowers with which the ship is fitted, in addition to the eight steam blowers which run at all times. When the days are short some extra coal would be used for the extra lights used and for the longer hours.

The amount of coal taken out of the bunkers for use at the galley each day varies from nothing to ½ tons, and the amount taken out for the launches also varies from nothing to ½ tons. The amount expended for distilling water over and above the normal of 5500 gallons varies from nothing to 3¾ tons. Therefore normal fluctuations of the daily coal account in port may be expected from 14½ tons to 19¼ tons.

AT SEA.

At sea the amounts used would be diminished by the quantity required for the auxiliary air and circulating pump and steam launches and boat cranes, and increased by the following:

Coal to allow for radiation and unavoidable leaks from the boilers and steam pipes, cylinders, piston rod and valve stem stuffing boxes. This varies slightly with the number of boilers in use and the speed of the engines.

Coal to run two main air pumps, two main circulating pumps, and steering engine. This varies very slightly with the speed of the engines. At higher speeds, when all boilers are in use, one extra feed pump will be required.

Coal for the main engines, with clean bottom and smooth sea, varies approximately as the I. H. P., or cube of the revolutions, and the two-thirds power of the displacement.

Coal to overcome the resistance due to foul bottom and foul screw.

Coal to overcome resistance due to head wind and sea.

If the quality of the coal in use at any time is below the standard of good coal, a correction will have to be applied to the sum of all these quantities. Also a further correction, if the firing is forced, to allow for the waste incidental to this condition, and also to allow for the steam required for the forced draft blowers, if they are used.

It is evident from the foregoing that a general equation for the coal consumption per day of any ship, under any condition of service, may be expressed as follows:

$$X = pq[C + t + u + c(1 \pm mn + w \pm y)IHP_t]$$

X = coal consumption in tons per day at sea, for all purposes.

p = ratio of the heating value of the best Welsh coal, to the heating value of the coal used.

q = ratio of the coefficient of efficiency of the boilers under normal firing, i. e. when burning from 14 to 15 pounds of coal per square foot of grate surface, in the case of Scotch boilers, to their efficiency under forced firing.

C = consumption of coal in tons per day when the main engines are stopped at sea, all auxiliaries continuing in use, and the fires in condition to go ahead at a moment's notice and ¾ boiler power in use.

t = extra coal required to distil, make up feed due to unusual leakage of boilers, piston rod and valve stem stuffing boxes. This should be small, but may be great; cannot, however, exceed the difference between the amount of coal used for normal distilling and that for running the distillers at their maximum capacity.

u = extra coal required to run main feed pumps, two main air pumps, two main circulating pumps when the main engines are developing more than half their full power.

c = a number by which the I. H. P.$_t$ is to be multiplied to get the number of tons of coal per day burned to produce the steam used in the main engines. This is practically constant for any given engine for medium speeds.

m = per cent for each 100 tons variation of displacement by which the I. H. P.$_t$ obtained on the trial displacement is to be

corrected to get the I. H. P.$_c$ at the actual displacement for the time in question.

n = the number of hundred tons the displacement at the time differs from the trial displacement.

w = per cent to be added to the normal I. H. P.$_t$ due to the displacement at the time, to allow for the increased resistance due to foul bottom and screw.

y = per cent to be added to the normal I. H. P.$_c$ due to existing displacement and condition of bottom if the wind and sea are ahead, and to be subtracted if astern.

No coefficient is provided for difference in firing. The general average of skill on one naval vessel is very much the same as on another, owing to the frequent changes in the crews and rapid promotion and to the fact that the slow speed of naval cruising does not tend either to develop skill or to give scope for its exercise. Moreover, warships generally cruise in squadron and use a large surplus of boiler power in order to perform evolutions or to be ready to increase the speed at short notice. Under these conditions the one paramount object is to keep position in squadron and the firemen are most exercised in maintaining a uniform pressure of steam with a widely varying speed of the engines and considerations of economy are not allowed to interfere.

Obviously this general equation cannot be solved, but, by taking advantage of favorable opportunities, the values of the constants and the limiting values of the variables can be found and then the equation can be used for determining, with a fair degree of accuracy, the daily coal consumption of a given ship under given conditions, and will serve as a check on the reports made by the water tenders. If the amount reported is less than that given by the equation, it will be known at once to be wrong. If the amount reported is greater, then the cause of the excess can be sought and the waste, if any, stopped.

The following method was used for getting the quantities required to adapt the equation for use on the U. S. S. Illinois. This ship having practically the same hull and same screw propellers as the U. S. S. Kearsarge, the data obtained for the latter ship in December, 1901, is applicable and is as follows:

TABLE II.

DATA FROM SPEED AND HORSE POWER CURVES OF U. S. S. KEARSARGE ON DISPLACEMENT OF 11,738 TONS, MEAN DRAFT 24 FEET 1⅛ INCHES.

Revolutions per minute.	Speed in knots per hour.	I. H. P.₁	Calculated coal in tons per day for all purposes.
50	7.9	890	40.8
55	8.7	1190	46.3
60	9.4	1600	53.9
65	10.2	2000	61.4
70	10.9	2500	70.7
75	11.6	3050	80.9
80	12.3	3700	93.0
85	13.0	4500	107.9
90	13.7	5400	130.
95	14.3	6450	156.
100	15.0	7650	186.
105	15.6	9000	222.
110	16.3	10500	263.
114	16.8	11674	302.

NOTE.—(1) The speed corresponding to the revolutions cannot be read from the speed curve closer than 0.05 knots.

(2) The I. H. P. corresponding to the revolutions cannot be read closer than 50 I. H. P., so that there may be an error of one ton of coal per day due to this cause. The two lowest points are calculated from the data in the report of the trial, the curve being too flat at this part for accuracy.

In using this table and the equation, it is important to note that the daily coal consumption will be found to vary far more regularly with the change in the revolutions of the engines than it does with the change in the speed of the ship as registered by the patent log. If it is desired to know what the speed of the ship is on any given daily consumption of coal, the coal must be calculated on the basis of revolutions, and the speed of the ship determined by the observations of the navigator, unless the sea is smooth and there is no wind, in which case the table will give the speed, if the displacement is the same as on the trial.

To proceed: On two long runs made by the Illinois, men were stationed at the bunker doors to tally the coal, and ten buckets were weighed every four hours. The following data was obtained:

	Days.	Revolutions.	Tons per day.	No. boilers.
New York en route to Azores.....	5	54	*46	4
Cape Verde Islands to Trinidad....	8	66	*64.6	6

*These are the amounts found by tally and corrected for a normal day of 24 hours and for excess of water distilled over and above the normal 5400 gallons.

The conditions at the time were:

Good coal	$\therefore p=1$
Normal rate of combustion	$\therefore q=1$
No excessive leakage	$\therefore t=0$
No extra speed for auxiliaries	$\therefore s=0$
Bottom clean	$\therefore w=0$
Wind light and sea smooth	$\therefore y=0$

To get the value of m and n. On the progressive trial we have for the Kearsarge, mean draft 24 feet 1⅛ inches, displacement 11,738 tons.

For the Illinois, normal mean draft leaving port, 25 feet 11 inches, displacement 12,743 tons. This includes six months' clothing and three months' provisions, total 170 tons, variation probably 70 tons; and ammunition 500 tons, variation practically nothing. After expending 1000 tons of coal and provisions the displacement will be 11,743 tons, then $\frac{12743^{\frac{2}{3}}}{11743^{\frac{2}{3}}} = 1.05628$. The variation in I. H. P. due to change in displacement = 5.628 per cent per 1000 tons, or 0.5628 per cent per 100 tons = m.

Let n represent the number of hundred tons difference between the actual displacement at any time and the minimum.

For the first run 54 revolutions, the mean displacement was 700 tons in excess $\therefore n=7$, $nm=7\times.563=4$ per cent to be added to the H. P. 1127 in the table, giving 1172 H. P.

For the second run, at 66 revolutions, the mean displacement was 606 tons in excess $\therefore n=6$, $nm=6\times.563=3.4$ per cent to be added to the H. P. 2100 in the table, giving 2171 H. P.

Substituting all of the above values in the general equation, we get,

(1) $\quad 46 = C + 1172\ c$

(2) $\quad 64.6 = C + 2171\ c$

$18.6 = \quad 999\ c \quad \therefore c = 0.0186$
$\& C = 24.2$

Inserting these two constants in the general equation, we have for the Illinois and class, viz., Kearsarge, Kentucky, Alabama and Wisconsin, $X = 24.2 + .0186\ (1 \pm mn)$ I. H. P_1 when the bottom is clean, the sea smooth, there is no wind, the water distilled and speed of auxiliary machinery are normal, the coal good, and the proper area of grate surface is used.

To illustrate the manner of using the equation, the coal expenditure on a certain run made by the Illinois has been calculated from the revolutions made by the engines and compared with the actual amount used, as determined by an accurate estimate of the bunkers at the end of the run. The results are given in Table III.

TABLE III.

WIND 1 TO 4.5 SEA S. TO M. GOOD OCEAN MERTHYR COAL. $m\ n = 3\frac{1}{2}$ %

Date Sept. 1902.	Days.	Revolutions. per minute.	Number of boilers.	Tons per day.	Total.
6-10	$3\frac{5}{8}$	85	All	110.8	401.6
10th	$\frac{7}{24}$	96	All	152.0	44.2
10-12	$1\frac{5}{8}$	Banked fires.	All	24.2	40.0
12th	$\frac{1}{24}$	50	¾ boiler power.	41.3	1.7
12-15	$2\frac{5}{8}$	69	¾ boiler power.	70.2	201.4
15th	$\frac{1}{24}$	65	¾ boiler power.	62.7	13.1
				Total	702.0

The amount used as found by an accurate estimate of the bunkers was 718 tons. The difference between 702 tons as calculated and 718 tons, the amount found by estimating the bunkers at the end of the run, although small, amounting as it does to only 2 1/3 per cent, can be partly accounted for by the fact that there was a head wind for a portion of the time and also by the forced firing required to make 96 revolutions. The method of doing this will be explained later on.

EFFECT OF FOUL BOTTOM.

In order to get a value for w adapted for use in the general equation, a continuous record should be kept of indicator cards taken in smooth water and calm weather. The gradual increase from month to month of the power required to produce a given number of revolutions will show pretty accurately the effect of the fouling of the bottom and give a value for w which may be relied on to determine in advance the coal consumption for the next run.

EFFECT OF WIND AND SEA.

That the wind must have an appreciable effect on the speed of a battleship is evident when we consider the flat surface presented.

The projected area of that part of the superstructure above the upper deck, together with the conning tower, chart house and two bridge screens of the Illinois, amounts to 1406 square feet, which would form a good-sized sail.

Some idea may be had of the effect of the wind by observing the increase in the slip of the screw, but owing to the vagaries of the patent log, and the mishaps to which it is subject, little dependence can be placed on such determination.

A far more accurate and sensitive measure is the gauge on the H. P. valve chest. The two gauges, one on each engine, serve as a check on each other, and if either behaves suspiciously it can be taken down at once and tested.

It is evident that, if the number of revolutions, vacuum, and the position of the H. P. cut-offs remain the same, the weight of steam admitted to the engines per minute will vary pretty nearly with the density due to the pressure in the H. P. valve chest, commonly called the throttle pressure. The method of utilizing the indications of the throttle gauge can best be shown by an example.

Referring to the engine log of the dates September 6th to 15th, the run previously quoted, it is found that with the wind abeam, or very light, a speed of 85 revolutions per minute was maintained with a throttle pressure of 115 pounds per gauge. For 28 hours, however, the wind and sea ahead were sufficiently strong so that a throttle pressure of 120 pounds was required. From a table of saturated steam it is found that the weight of a cubic foot of steam at 115 pounds per gauge is 0.2939 pounds and its weight at 120 pounds per gauge is .3046 pounds, an increase of 3.6 per cent. Multiplying the coal required for the main engines at 85 revolutions, viz., 86.8 tons per day, by 3.6 per cent and by 1⅛ days, we get 3.64 tons extra coal required due to the head wind on this occasion. Later on, when making 69 revolutions, we find that for 1⅓ days the throttle pressure was increased from a normal of 79 pounds to a pressure of 84 pounds, and from the tables the corresponding densities were .2165 and .2274 pounds, an increase of 5 per cent. The coal required for the engines at 69 revolutions being 46 tons per day, the total increase for 1⅓ days was 2.76 tons, which added to the 3.64 makes a total of 6.4 tons, accounted for by the weather, reducing the error of Table III from 2⅓ per cent to 1⅓ per cent.

The best method of getting the effect in I. H. P. of the wind pressure would be to take a series of cards in smooth water, leaving port, and another series after getting out into the open sea, with the wind ahead, taking care that the water be of sufficient depth always, for shoal water has a marked effect in increasing the power required to drive a ship.

The effect of a head sea can be measured in a similar manner.

EFFECT OF FORCED FIRING.

With regard to the value of q, an approximate maximum may be found by taking the ratio of the weight of coal used on the original contractors' trial, to that which would have been consumed if the speed could have been made with economical firing.

On the trial of the Kearsarge, the following data was obtained: I.H.P. developed by the main engines, 11,674; revolutions, 114; coal per hour, 28,209.5 pounds, New River, picked; displacement, 11,550 tons. By the formula the coal per day would be 241 tons, or 22521 pounds, per hour. Therefore $q = \frac{28209.5}{22521} = 1.25$.

The total grate surface being 685 square feet, the greatest amount of coal which can be burned per day at the economical rate of 15 pounds per square foot is 110 tons, corresponding to a speed of 85 revolutions per minute. We may assume then that for 85 revolutions $q = 1$, and for 114 revolutions $q = 1.25$, and by interpolation get the approximate intermediate values, viz.:

85 Rev.	$q = 1$
90 "	$q = 1.04$
95 "	$q = 1.08$
100 "	$q = 1.12$
105 "	$q = 1.16$
110 "	$q = 1.20$
114 "	$q = 1.25$

These values of q were used to calculate the last six quantities in Table II. If the value of q for 96 revolutions, viz., 1.09, be applied to the coal consumption in the second line of Table III, we find that the quantity 44.2 should be 48.1, and thus account for 3.9 tons, reducing the error from 1⅓ per cent to 0.35 per cent.

EFFECT OF THE QUALITY OF COAL.

The trade name of any coal is not a sufficiently exact index of its heating value.

A rough estimate of its quality may be made by steaming for 24 hours and comparing the maximum average number of revolutions obtainable with the maximum made on a similar previous run with the same number of boilers and weather conditions. A run of less than 24 hours would not be satisfactory for one of the most important points, viz., the loss by cleaning fires would be left undetermined. It is not often convenient, however, to make such trial runs.

It would be a great advantage if every lot of coal purchased at home ports was tested by an expert with a coal calorimeter and the information so obtained supplied to each ship taking that coal. At present, when, upon the receipt of a new lot of coal, there is an increase in the expenditure, or a falling off in the speed, the coal is assumed to be of poor quality, although such a loss might be only a coincidence and not a consequence. If it was known that the coal had a high calorimetric value, further investigation would reveal the true cause of the loss.

The general equation is based on the supposition that the number of boilers used is adapted to the speed made. It is evident that there are some speeds that will be too high, for say four boilers, and too low for five, and so on, requiring the fires to be urged in one case and to be checked in the other.

If an accurate coal consumption curve is ever constructed for any ship it is more than likely to be found not a smooth curve like that of the indicated horsepower, but one with a series of humps corresponding in number and size to the subdivision of the total boiler power of the vessel.

There is no data at hand to show how many tons per day may be wasted by running at unsuitable speeds, and until such information is forthcoming it would be advisable to choose a speed adapted to some whole number of boilers in the case of a single ship, and in the case of a squadron, a speed adapted to the least economical ship, or to the greatest number of ships.

The general equation as given having been constructed on correct principles, the accuracy with which results can be obtained on any ship will depend on the amount of labor, skill and ingenuity expended in getting the values of the constants and variables.

When we consider the importance of the mission of a war vessel and how much her sphere of usefulness might be extended

in critical situations if one knew exactly how much coal would be required to perform certain duty under certain conditions, what expenditures could be stopped entirely and what the saving would be in each case, then it would appear of greatest importance to subject one ship of each new type, early in her first commission, to a complete set of tests in order that the necessary data might be secured promptly and accurately instead of waiting years for opportunities to occur for getting the requisite knowledge of her capabilities and her limitations. Moreover, once obtained, this data would be invaluable for purposes of comparison from time to time to ascertain whether or not every part of her mechanism was working with due economy and efficiency; for ascertaining the relative cost of docking a ship or letting her cruise with a foul bottom; and most important of all, to enable the commanding officer to decide at any time what the ship can and cannot be expected to do, so that when setting out on an expedition he will not err on the side of either timidity or of rashness.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

"BLANK" TORPEDO SHOOTING.

By COMMANDER G. M. DAHL, Royal Norwegian Navy.

Demands made on a good captain of a torpedo-boat may be summed up in the following:

(1) To manage his boat with coolness in attack under all circumstances.

(2) To fire the torpedo at the right moment.

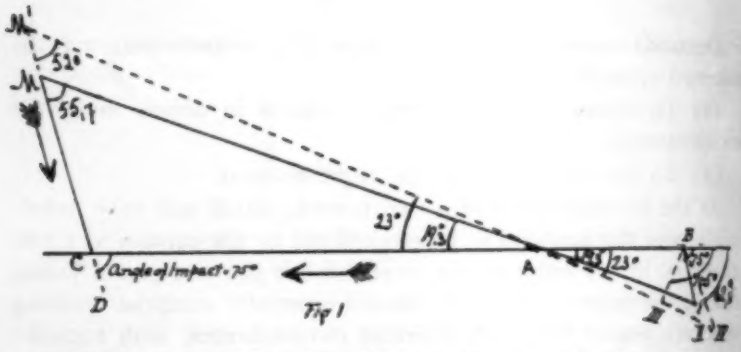
As the circumstances of a real torpedo attack can vary indefinitely, and the problem to be worked out by the captain in a real attack is, in my opinion, the most difficult you can give a young officer, the exercise in peace should especially comprise training in attack under the most different circumstances, with torpedo-shooting under warlike circumstances. It will be clear, that if, in each attack, you are to fire your torpedo, it will take a long time, and the practise in manœuvring the boat in attack will be too slight. Besides, the local conditions in most places, where you might wish to make a torpedo-attack, would forbid firing the torpedo. However, if the exercise in peace shall lead to a good result, these things should be practised *every day*, and under the most different circumstances as warlike as possible.

For this purpose I have worked out some tables by means of which you may easily determine the error committed by firing the torpedo, *and without firing it*. The tables have been tried last year on board the torpedo-boats of the Norwegian navy, and have been found very useful and instructive by the captains.

The tables will enable a captain to perform an attack wherever and whenever he likes, at the same time affording him the means to determine, precisely, whether a hit was secured or otherwise. Also, by means of the tables, you can systematically point out

and eliminate the errors made in the aim. This seems to be very important in the case of novices. There have been constructed "controlling instruments for blank torpedo shooting," by which you can determine the error of the shot. However, these instruments are expensive, and, in my opinion, they are more difficult to use than the tables, which, in addition, give you *all* the errors, while the controlling instrument usually is so constructed as to give you only the *total* error without telling you how the result was obtained.

I next proceed to set out how the tables are worked out, and how they are to be used.



The factors on which the hitting in torpedo-shooting depends are these:

(1) Speed of the torpedo.

(2) Speed of the enemy.

(3) Course of the enemy.

These three data given, you can construct the angle of aiming, that is, the angle under which the torpedo must be fired to hit the aim. In Fig. 1 this angle is constructed for the following case:

Speed of torpedo = 30 knots.

Speed of enemy = 12 knots.

Course of enemy = 75° = angle of impact.

In Fig. 1 *A* is place of torpedo-boat, *M* place of enemy at the moment of firing; the torpedo is fired along the line *AC*, and the enemy runs along the line *MC*.

If this torpedo is to hit the aim, *AC* must be proportional to speed of torpedo (30 knots), *MC* proportional to speed of enemy

(12 knots) and the angle $ACD = 75°$. Then you will find the angle of aiming $= MAC = 19°.3$.

Course of enemy must necessarily be determined in relation to the course of torpedo; it had then best be indicated by *the angle of impact of the torpedo, which is always counted from the bow of the enemy to the course-line of the torpedo, on the side of the ship where the torpedo hits.* Though this angle is external to the triangle, I have used it, because it is so easily determined, and because it is always interesting to know the angle of impact, which naturally in torpedo shooting is counted from the enemy's bow. From Fig. 1 it will be seen, that the angle of impact = the angle of aiming plus the torpedo-boat's angle of bearing from enemy. The angle of aiming is measured on the torpedo director and the angle of bearing, together with the speed of the enemy, are given you by the enemy. To avoid errors, when at small distances, the enemy ought to take the bearing of the torpedo-gun. However, a little error in the angle of bearing has but little influence on the result.

The speed of the torpedo being always known, the unknown factors of aiming will be *the speed of the enemy* and *the course of the enemy* (angle of impact), by which the angle of aiming is to be determined. It will easily be understood that the latter can be calculated for all cases and be put in a tabular form. This is what I have done in Table I, which gives the angles of aiming for 26-38 knot torpedoes for every 5° of the angle of impact from 30°-150° and for every knot of the enemy's speed from 6-22 knots.

As will be known, the torpedo director is an instrument by which you can graphically construct the angle of aiming. In Fig. 1 *ABI* means the director. If, in the above example, this is correctly adjusted, *AB* must be proportional to speed of torpedo (30 knots), *BI* proportional to speed of enemy (12 knots), and *BI* parallel to enemy's course-line *MC*. It will then be seen that the triangle *ABI* is similar to the triangle *ACM* and, consequently, the angle *BAI* constructed by the director equal to the angle $MAC = 19°.3$.

By the director a wrong angle may be got in three different ways:

1. By misreckoning speed of enemy.
2. By misreckoning the angle of impact.

3. By misreckoning speed of enemy as well as the angle of impact.

These three cases are illustrated in Fig. 1.

BI shows the director adjusted correctly.

BII shows misreckoning of the speed of the enemy—15 knots instead of 12—but angle of impact correct.

BIII shows misreckoning of the angle of impact—105° instead of 75°—but speed correct.

BIV shows misreckoning of the speed of the enemy—19 knots instead of 12—as well as misreckoning of the angle of impact—62°.5 instead of 75°.

As will be seen from *BII*, *BIII* and *BIV*, all of these give the same angle of aiming = 23°. Therefore, there is nothing to prevent a misreckoning of the speed of the enemy which may be compensated for by misreckoning of the angle of impact in the opposite direction.

If, in any of these ways, you have fired your torpedo under an erroneous angle—23° instead of 19°.3— it will be seen by Fig. 1 that you have fired the torpedo correctly for a position of the enemy at *M'* instead of at *M*, and, consequently, you will hit the distance *M'M* ahead of the aim.

With a view to systematically eliminating the errors made, you ought to know what the separate values are. By means of the tables the errors are found in the following manner:

The enemy takes a bearing at the torpedo-boat at the moment of firing the torpedo, which is indicated by hauling down a flag, by the whistle, etc. From Fig. 1 will be seen, that the angle of bearing = 52°. The correct angle of impact is then = 52° plus 23° = 75°. The true speed of the enemy = 12 knots. With these two data you go into the Table I for a 30 knot torpedo and find the angle of aiming = 19°.3. On the director you measure the reckoned angle of aiming = 23°. The error is then = 3°.7. On the director you also measure the reckoned angle of impact and the reckoned speed of the enemy. On comparing the latter with the true ones you will find the errors.

It will be seen from Fig. 1 that the error (*M'M*) depends upon the angle of impact, the speed of the torpedo, the speed of the enemy, and that the distance *M'M* is directly proportional to the distance from the torpedo-boat to the enemy. As the tables would run to too large an extent, were I to calculate the error

for every knot of the speed of the enemy, I have but calculated for every 5 knots, every 10° of the angle of impact and every 2 knots of the speed of the torpedo. Table II is calculated in this way and refers to a distance of 100 m. The error for another distance, say 400 m., is then easily calculated by multiplying by 4. The error is calculated per 1 degree's error of the angle of aiming. By distance is meant the distance that the torpedo must run before hitting the enemy *(AC)*. However. as you reckon or measure the distance *AM'* at the moment of firing, you must rectify this to get the distance of the torpedo.

From Fig. 1 it will be seen that the difference between *AM'* and *AC* depends upon the angle of aiming and the angle of impact. With these two data Table III is calculated. Table III gives the factor by which the measured or reckoned distance is to be multiplied so as to give the distance to be run by the torpedo.

As the error in hitting is directly proportional to the distance, it ought to be one of the most important objects of the captain of a torpedo-boat to get as close to his enemy as possible. Experience shows that one is apt to reckon the distance too short. For this reason judging of distances must be considered as a necessary element in the training of the torpedo officer.

To secure a systematic training with the means of tracing all errors made, a scheme should be framed, as shown, for entries to be inserted after each exercise. You will then get a clear view of the errors made, and be enabled to correct each of them. This will be of much importance when novices are to be trained in torpedo shooting.

To begin with, the learner himself should be stationary; if there are several novices, you can place the directors, in any number required, on shore or on board of a ship, and let them aim all at the same time at a torpedo boat crossing the aiming line at different speeds and on different courses. Only one of them has the command, and marks the firing of the torpedo, the rest leaving their directors alone after the firing of the torpedo, and you may then in every director pick out the data wanted.

Later on, they are trained under speed and by attacks under various circumstances. The object of these trainings ought to be to fire the torpedo under the right angle without using the director, that is, shooting on the wing. For this purpose somebody else is adjusting the director during the exercise so as to

get the angle under which the torpedo is fired. The torpedo director is indeed an excellent instrument to determine the angle of aiming, but you may safely take it for granted that, in the night time, on board a torpedo-boat, it will be impossible to use it, and, moreover, the captain of a torpedo-boat in a night-attack has other things to think of than adjusting the director, so that he scarcely will have time or presence of mind enough to try it, even if it were possible. Under such circumstances you must know the angle of aiming by heart and be independent of the director, which ought to be the object you must propose to yourself in training in times of peace.

In the scheme for torpedo-training I have a column for manœuvre. In this column is entered a short critique of the manœuvre performed. This critique is best done from the ship, which represents the enemy.

To illustrate the use of the tables I shall now go through the example which is shown in the last line in the scheme.

On the director is taken:

The reckoned angle of aiming = 23°.
The reckoned speed of the enemy = 19 knots.
The reckoned angle of impact = 62°.5.

From the enemy you get:

The angle of bearing = 52°.
The true speed of the enemy = 12 knots.
The true distance = 560 m.
The data are inserted in the form.
The true angle of impact = 23° + 52° = 75°.

From Table I for a 30 knot torpedo, with the angle of impact = 75°, the speed of the enemy = 12 knots, is found the true angle of aiming = 19°.3.

From Table III, with the angle of impact = 75° and the angle of aiming = 20°, is found the factor 0.85. The distance of the torpedo is then = 560 × 0.85 = 475 m.

From Table II it is found that an error of 1° of the angle of aiming with the angle of impact = 75°, the speed of the torpedo = 30 knots, and the speed of the enemy = 12 knots, gives an error of 2.8 m. from the aim at a distance of 100 m.

The hit is then = 2.8 × 3.7 × 4.75 = 49.2 m. ahead.

TABLE I.—26 KNOTS TORPEDO.

Speed of Enemy.	The Angle of Impact.																								
	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°	125°	130°	135°	140°	145°	150°
6	5.8	6.3	7.2	8.	8.6	9.2	9.8	10.6	11.2	11.9	12.2	12.7	13.2	13.2	13.3	13.3	13.1	12.9	12.7	12.2	11.8	11.2	10.1	9.2	8.3
7	6.1	7.1	8.1	9.	9.7	10.5	11.2	12.1	12.9	13.6	14.2	14.6	15.2	15.3	15.5	15.6	15.4	15.3	15.2	14.2	13.9	13.3	11.1	10.9	9.1
8	6.9	8.	9.1	10.1	11.	11.9	12.7	13.6	14.5	15.4	16.	16.6	17.2	17.4	17.6	17.8	17.6	17.5	17.4	16.7	16.1	15.5	14.	12.6	11.3
9	7.6	8.8	10.	11.1	12.2	13.2	14.1	15.1	16.	17.	17.7	18.4	19.1	19.5	19.8	20.	20.	20.	20.1	19.3	18.6	18.	16.5	15.	13.6
10	8.3	9.6	10.8	12.1	13.3	14.4	15.6	16.6	17.6	18.7	19.4	20.2	21.1	21.5	22.	22.4	22.5	22.6	22.6	21.9	21.1	20.5	19.	17.5	15.9
11	8.8	10.2	11.6	12.8	14.3	15.5	16.7	17.9	19.	20.	21.1	22.	23.	23.5	24.	24.5	24.8	24.9	25.1	24.9	23.7	23.	21.4	19.7	18.1
12	9.3	10.8	12.3	13.8	15.2	16.5	17.9	19.1	20.4	21.7	22.7	23.7	24.8	25.5	26.1	26.8	27.	27.2	27.4	26.8	26.2	25.6	23.8	22.	20.3
13	9.9	11.5	13.	14.5	16.1	17.6	18.9	20.5	21.3	23.1	24.3	25.4	26.6	27.4	28.2	27.	29.3	29.7	30.	29.5	27.	28.5	27.1	24.5	23.6
14	10.4	12.1	13.7	15.3	17.	18.7	20.4	21.9	22.2	24.6	25.8	27.1	28.4	29.3	30.2	31.1	31.6	32.1	32.6	32.2	31.9	31.6	30.3	27.	26.8
15	10.9	12.7	14.6	16.1	17.8	19.5	21.1	22.7	23.9	25.8	27.	28.4	30.	31.1	32.	33.	33.8	34.5	35.	34.9	34.8	34.7	33.3	30.9	30.1
16	11.4	13.3	15.	16.9	18.6	20.3	22.1	23.8	25.5	27.1	28.6	30.2	31.7	32.8	34.9	34.9	35.9	36.8	37.6	37.6	37.6	37.7	36.2	34.8	33.3
17	11.8	13.8	15.6	17.5	19.4	21.2	23.	24.8	26.6	28.1	29.9	31.5	33.	34.4	35.6	36.9	38.	39.	40.	40.3	40.5	40.8	39.5	38.3	37.
18	12.2	14.2	16.2	18.2	20.1	22.	23.9	25.8	27.6	29.4	31.2	32.8	34.6	36.	37.3	38.8	40.	41.2	42.	42.9	43.4	43.8	42.6	41.8	40.9
19	12.6	14.7	16.7	19.8	20.8	22.8	24.8	26.8	28.7	30.5	32.5	34.2	36.	37.6	39.2	40.7	42.1	43.5	44.7	45.6	46.3	46.9	46.3	45.6	44.9
20	13.	15.1	17.2	19.4	21.5	23.6	25.8	27.8	29.8	31.8	33.7	35.6	37.5	39.2	41.	42.6	44.2	45.8	47.2	48.3	49.3	50.1	49.8	49.4	49.
21	13.4	15.6	17.7	20.	22.1	24.3	26.4	28.6	30.7	32.	34.9	36.9	38.8	40.7	42.6	44.4	46.1	47.8	49.4	50.7	52.	53.	53.8	53.3	53.3
22	13.8	16.	18.1	20.6	22.7	24.9	27.2	29.4	31.6	33.8	36.	38.1	40.2	42.2	44.2	46.2	48.	49.8	51.7	53.1	54.7	56.1	56.7	57.2	57.7

TABLE I.—28 KNOTS TORPEDO.

Speed of Enemy.	The Angle of Impact.																								
	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°	125°	130°	135°	140°	145°	150°
6	5.2	6.	6.7	7.5	8.	8.6	9.4	9.9	10.4	11.1	11.5	12.1	12.7	12.5	12.4	12.3	12.2	12.	11.7	11.2	10.6	10.2	9.2	8.3	7.5
7	5.9	6.8	7.1	8.4	9.2	9.9	10.8	11.4	12.	12.7	13.2	13.8	14.5	14.4	14.4	14.4	14.3	14.1	13.9	13.3	12.6	12.1	11.	10.	9.
8	6.5	7.5	8.5	9.5	10.4	11.2	12.7	12.8	13.6	14.4	14.9	15.5	16.1	16.2	16.4	16.5	16.4	16.2	16.	15.4	14.8	14.1	12.9	11.7	10.5
9	7.2	8.2	9.3	10.4	11.5	12.4	13.4	14.2	15.	15.9	16.5	17.2	18.	18.1	18.4	18.6	18.5	18.4	18.4	17.7	17.1	16.4	15.	13.8	12.2
10	7.9	9.	10.2	11.4	12.5	13.6	14.6	15.6	16.5	17.5	18.2	18.9	19.7	20.	20.4	20.6	20.6	20.6	20.6	20.	19.4	18.7	17.1	15.8	14.5
11	8.4	9.6	11.	12.2	13.5	14.7	15.8	16.8	17.9	18.9	19.8	20.5	21.5	22.	22.4	22.7	22.8	22.9	23.	22.4	21.7	21.1	19.5	18.	16.
12	8.9	10.3	11.7	13.1	14.4	15.7	17.	18.1	19.3	20.4	21.4	22.3	23.3	23.9	24.4	24.8	25.1	25.2	25.3	24.7	24.1	23.4	21.8	20.1	18.3
13	9.4	10.9	12.4	13.8	15.3	16.7	18.	19.8	20.6	21.7	22.8	23.8	24.9	25.7	26.3	26.9	27.2	27.4	27.6	27.1	26.5	25.9	24.4	22.8	20.6
14	9.9	11.5	13.	14.6	16.1	17.6	19.	20.5	21.8	23.	24.2	25.4	26.6	27.4	28.2	29.	29.3	29.6	29.9	29.5	29.	28.4	27.	25.5	23.5
15	10.3	12.1	13.7	15.3	16.7	18.5	20.1	21.6	23.	24.3	25.6	26.9	28.2	29.1	30.1	30.9	31.5	31.8	32.3	32.1	31.7	31.3	29.8	28.3	26.3
16	10.8	12.6	14.3	16.	17.3	19.4	21.1	22.6	24.2	25.7	27.	28.4	29.8	30.8	31.9	32.9	33.6	34.1	34.7	34.6	34.4	34.2	32.6	31.	29.4
17	11.2	13.1	14.9	16.6	18.2	20.2	22.	23.6	25.2	26.9	28.3	29.8	31.2	32.2	33.6	34.6	35.	36.3	37.	37.1	37.	37.	35.5	34.	32.4
18	11.6	13.6	15.5	17.5	19.1	21.	22.8	24.6	26.2	28.1	29.6	31.2	32.7	34.	35.2	36.3	37.4	38.4	39.4	39.5	39.6	39.8	38.4	37.	35.8
19	12.	14.	16.	18.	19.8	21.7	23.6	25.5	27.2	29.1	30.8	32.4	34.1	35.5	36.8	38.2	39.3	40.5	41.5	42.	42.4	42.7	41.6	40.5	39.2
20	12.4	14.4	16.4	18.7	20.4	22.4	24.4	26.3	28.2	30.1	32.	33.6	35.5	37.	38.4	40.	41.2	42.6	43.7	44.4	45.1	45.6	44.8	44.	43.
21	12.7	14.8	16.9	19.1	21.1	23.1	25.2	27.2	29.2	31.2	33.1	34.9	36.8	38.5	40.	41.7	43.1	44.5	45.8	46.7	47.6	48.4	47.9	47.3	46.5
22	13.1	15.2	17.4	19.6	21.7	23.8	26.1	28.	30.1	32.2	34.2	36.2	38.1	40.	41.6	43.4	44.9	46.4	48.	49.	50.	51.3	51.	50.7	50.2

TABLE I.—30 KNOTS TORPEDO.

Speed of Enemy.	The Angle of Impact.																								
	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°	125°	130°	135°	140°	145°	150°
6	4.9	5.6	6.4	7.1	7.6	8.3	9.	9.4	9.9	10.4	10.8	11.1	11.4	11.5	11.5	11.5	11.3	11.1	10.9	10.4	9.9	9.4	8.4	7.4	6.7
7	5.6	6.4	7.2	8.	8.7	9.5	10.2	10.8	11.9	12.	12.4	12.8	13.2	13.3	13.4	13.4	13.3	13.1	13.	12.3	11.8	11.2	10.2	9.1	8.4
8	6.1	7.1	8.	9.	9.8	10.6	11.5	12.1	12.8	13.5	14.	14.5	15.	15.1	15.2	15.3	15.2	15.1	15.	14.2	13.6	13.	11.9	10.8	9.8
9	6.8	7.8	8.9	9.9	10.8	11.7	12.7	13.5	14.2	15.	15.6	16.2	16.8	17.	17.1	17.2	17.3	17.2	17.1	16.4	15.7	15.	13.9	12.6	11.4
10	7.4	8.6	9.7	10.8	11.9	12.9	14.	14.8	15.7	16.5	17.2	17.9	18.6	18.8	19.	19.2	19.3	19.3	19.2	18.5	17.8	17.1	15.8	14.4	13.1
11	7.9	9.2	10.4	11.6	12.8	13.9	15.	16.	17.	17.9	18.7	19.5	20.1	20.6	20.9	21.1	21.3	21.3	21.4	20.8	19.9	19.3	17.8	16.2	14.8
12	8.4	9.8	11.1	12.4	13.7	14.9	16.1	17.2	18.2	19.3	20.2	21.	21.9	22.3	22.7	23.	23.2	23.3	23.5	22.7	22.	21.4	19.7	18.	16.4
13	8.9	10.3	11.7	13.1	14.5	15.8	17.1	18.3	19.4	20.5	21.6	22.5	23.5	24.1	24.6	25.	25.3	25.5	25.7	25.	24.3	23.7	22.1	20.5	18.8
14	9.3	10.8	12.3	13.8	15.2	16.7	18.1	19.3	20.6	21.9	23.	24.	25.1	25.8	26.5	27.	27.4	27.6	27.8	27.2	26.6	26.1	24.5	23.	21.3
15	9.8	11.4	13.	14.6	16.1	17.6	19.1	20.4	21.7	23.	24.3	25.4	26.6	27.4	28.2	29.	29.3	29.7	30.	29.5	29.	28.6	27.	25.4	23.8
16	10.3	12.	13.7	15.3	16.9	18.5	20.1	21.5	22.8	24.8	25.5	26.8	28.1	29.	29.8	30.8	31.2	31.7	32.1	31.8	31.4	31.	29.4	27.8	26.3
17	10.8	12.5	14.3	16.	17.6	19.3	21.	22.5	23.9	25.4	26.7	28.2	29.6	30.6	31.5	32.7	32.2	33.8	34.3	34.2	34.	33.7	32.2	30.7	29.
18	11.2	13.	14.8	16.6	18.2	20.	21.8	23.4	25.	26.5	28.1	29.6	31.	32.1	33.2	34.4	35.1	35.8	36.5	36.6	36.5	36.4	35.	33.5	32.
19	11.6	13.5	15.3	17.2	18.9	20.8	22.6	24.3	26.	27.7	29.8	30.8	32.3	33.6	34.9	36.2	37.	37.9	38.7	38.9	39.	39.	37.8	36.5	35.
20	11.9	13.9	15.8	17.8	19.6	21.5	23.4	25.2	27.	28.8	31.4	32.	33.7	35.1	36.4	38.	38.8	39.9	40.9	41.2	41.5	41.8	40.6	39.5	38.3
21	12.3	14.3	16.3	18.3	20.1	22.2	24.1	26.	28.	29.9	32.1	33.2	35.	36.5	38.	39.5	40.6	41.8	43.	43.5	44.	44.3	43.6	42.7	41.7
22	12.6	14.6	16.7	18.8	20.8	23.8	24.8	26.8	29.	31.	32.7	34.4	36.2	37.9	39.5	41.2	42.3	43.6	45.1	45.8	46.5	47.2	46.5	45.8	45.2

TABLE I.—32 KNOTS TORPEDO.

Speed of Enemy.	The Angle of Impact.																								
	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°	125°	130°	135°	140°	145°	150°
6	4.6	5.3	6.	6.7	7.3	7.8	8.5	8.7	9.3	9.8	10.2	10.6	11.1	11.	11.	11.	10.7	10.4	10.2	9.8	9.2	8.8	7.9	7.	6.2
7	5.2	6.1	6.8	7.6	8.3	8.9	9.7	10.2	10.7	11.2	11.7	12.2	12.7	12.7	12.7	12.7	12.5	12.3	12.	11.7	11.4	10.4	9.5	8.6	7.7
8	5.9	6.8	7.6	8.5	9.2	10.	10.9	11.5	12.1	12.7	13.2	13.7	14.2	14.3	14.4	14.5	14.3	14.1	13.9	13.3	12.6	12.	11.	10.1	9.1
9	6.4	7.5	8.4	9.4	10.2	11.1	11.9	12.7	13.4	14.1	14.7	15.3	15.9	16.	16.2	16.2	16.2	16.	15.8	15.2	14.6	13.9	12.8	11.7	10.6
10	7.	8.1	9.1	10.2	11.1	12.1	13.1	13.9	14.7	15.6	16.2	16.8	17.5	17.7	17.9	18.1	18.	17.9	17.7	17.1	16.4	15.8	14.5	13.2	12.
11	7.5	8.8	9.9	11.	12.1	13.1	14.1	15.1	16.	16.9	17.6	18.4	19.1	19.4	19.7	20.	19.9	19.8	19.7	19.6	18.5	17.8	16.4	14.8	13.8
12	8.	9.4	10.7	11.9	13.	14.	15.1	16.2	17.2	18.2	19.	19.8	20.6	21.	21.5	21.7	21.8	21.8	21.8	21.1	20.5	19.8	18.3	16.3	15.8
13	8.5	9.9	11.3	12.5	13.8	15.	16.2	17.3	18.4	19.5	20.4	21.3	22.2	22.7	23.2	23.7	23.7	23.7	23.9	23.1	22.6	21.9	20.3	18.4	17.2
14	9.	10.4	11.8	13.2	14.5	15.9	17.3	18.4	19.6	20.7	21.7	22.7	23.7	24.3	24.8	25.4	25.5	25.6	25.9	25.2	24.7	24.1	22.3	20.4	18.8
15	9.4	11.	12.5	13.9	15.3	16.8	18.2	19.5	20.7	22.	23.	24.1	25.1	25.9	26.6	27.2	27.5	27.7	28.	27.4	27.	26.4	24.7	22.9	21.4
16	9.9	11.5	13.1	14.5	16.	17.6	19.1	20.5	21.8	23.2	24.2	25.4	26.6	27.5	28.3	29.1	29.5	29.7	30.	29.6	29.2	28.8	27.	25.4	23.8
17	10.3	12.	13.6	15.2	16.7	18.3	20.	21.4	22.8	24.2	25.5	26.7	28.	29.	29.9	30.7	31.2	31.7	32.	31.8	31.4	31.1	29.5	28.	26.4
18	10.7	12.4	14.1	15.9	17.4	19.	20.8	22.3	23.8	25.3	26.7	28.	29.4	30.4	31.4	32.4	33.	33.6	34.1	33.9	33.6	33.4	31.9	30.5	29.
19	11.	12.9	14.7	16.5	18.1	19.8	21.6	23.2	25.3	26.4	27.9	29.3	30.8	31.9	33.	34.1	34.8	35.5	36.1	36.1	36.	35.9	34.5	33.2	31.8
20	11.4	13.3	15.2	17.1	18.8	20.5	22.4	24.	26.8	27.5	29.	30.5	32.2	33.3	34.6	35.8	36.6	37.4	38.2	38.3	38.4	38.4	37.	35.8	34.4
21	11.8	13.7	15.7	17.6	19.4	21.2	23.1	24.9	27.2	28.6	30.	31.6	33.4	34.7	36.1	37.3	38.3	39.3	40.3	40.9	40.7	40.8	39.6	38.5	37.
22	12.2	14.1	16.1	18.	20.	21.9	23.8	25.7	27.6	29.6	31.	32.8	34.6	36.	37.6	38.8	40.	41.2	42.4	42.6	42.9	43.2	42.2	41.1	40.

TABLE I.—34 KNOTS TORPEDO.

Speed of Enemy.	The Angle of Impact.																							
	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°	125°	130°	135°	140°	145°	150°
6	4.4	5.	5.7	6.4	6.9	7.4	8.	8.4	8.8	9.3	9.6	9.9	10.2	10.2	10.2	10.2	10.	9.7	9.5	9.	8.6	8.2	7.3	6.8	5.9
7	5.	5.7	6.5	7.2	7.8	8.5	9.1	9.7	10.2	10.7	11.1	11.4	11.7	11.8	11.9	11.9	11.7	11.5	11.3	10.7	10.2	9.8	8.8	8.1	7.2
8	5.7	6.4	7.3	8.1	8.8	9.6	10.3	10.9	11.5	12.1	12.5	12.9	13.3	13.4	13.5	13.6	13.4	13.2	13.	12.4	11.8	11.3	10.2	9.4	8.4
9	6.2	7.1	8.	8.9	9.8	10.7	11.3	12.1	12.8	13.4	13.9	14.4	14.9	15.	15.2	15.3	15.2	15.	14.8	14.2	13.6	13.	11.9	10.9	9.8
10	6.7	7.7	8.7	9.7	10.7	11.6	12.4	13.2	14.	14.8	15.3	15.9	16.5	16.6	16.8	17.	16.9	16.8	16.6	16.	15.4	14.8	13.6	12.4	11.1
11	7.2	8.4	9.5	10.6	11.6	12.6	13.5	14.3	15.2	16.1	16.7	17.4	18.	18.3	18.5	18.8	18.7	18.6	18.5	17.9	17.2	16.7	15.3	14.1	12.7
12	7.7	9.	10.3	11.4	12.5	13.5	14.5	15.4	16.4	17.4	18.	18.8	19.5	19.9	20.2	20.6	20.5	20.4	20.4	19.8	19.	18.4	17.	15.6	14.3
13	8.1	9.5	10.8	12.1	13.2	14.4	15.4	16.5	17.5	18.6	19.3	20.2	21.	21.5	21.9	22.2	22.3	22.3	22.3	21.7	21.	20.2	18.8	17.3	16.
14	8.6	10.	11.2	12.8	13.9	15.2	16.4	17.6	18.6	19.8	20.6	21.6	22.5	23.	23.5	23.9	24.	24.1	24.2	23.6	23.	22.2	20.5	19.	17.6
15	9.	10.5	12.2	13.4	14.7	15.8	17.4	18.5	19.2	20.9	31.8	22.9	23.9	24.5	25.1	25.6	25.8	26.	26.1	25.6	25.	24.4	22.6	21.	19.3
16	9.5	11.	13.1	14.	15.4	16.4	18.4	19.4	20.7	22.	23.	24.1	25.3	26.	26.6	27.3	27.5	27.8	28.	27.6	27.1	26.6	24.6	23.	20.9
17	9.9	11.5	13.3	14.6	16.1	17.3	19.1	20.3	21.7	23.1	24.2	25.4	26.6	27.4	28.2	29.	29.3	29.6	29.9	29.6	29.2	28.8	26.9	25.3	23.4
18	10.3	11.9	13.6	15.3	16.7	18.2	19.9	21.2	22.7	24.2	25.4	26.6	28.	28.8	29.7	30.5	31.	31.4	31.9	31.6	31.2	31.	29.2	27.6	26.
19	10.6	12.3	13.8	15.8	17.4	19.	20.6	22.1	24.2	25.2	26.6	27.8	29.2	30.2	31.2	32.1	32.3	33.3	33.9	33.7	33.4	33.2	31.6	29.9	28.5
20	11.	12.8	14.	16.4	18.	19.8	21.4	23.	25.6	26.2	27.7	29.	30.5	31.6	32.7	33.8	34.4	35.1	35.8	35.7	35.6	35.4	34.	32.2	31.
21	11.4	13.2	14.7	17.	18.5	20.4	22.1	23.8	26.	27.2	28.7	30.2	31.7	32.9	34.2	35.3	36.1	36.9	37.7	37.7	37.7	37.6	36.5	35.	33.6
22	11 8	13.6	15.4	17.5	19.	21.	22.9	24.6	26.4	28.2	29.8	31.3	33.	34.2	35.6	36.9	37.8	38.6	39.5	39.6	39.7	39.8	39.	37.8	36.2

TABLE I.—36 KNOTS TORPEDO.

Speed of Enemy.	The Angle of Impact.																							
	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°	125°	130°	135°	140°	145°	150°
6	4.2	4.8	5.4	6.	6.5	7.	7.6	8.	8.4	8.8	9.1	9.3	9.6	9.7	9.7	9.8	9.6	9.3	9.	8.5	8.	7.6	6.8	6.1	5.5
7	4.7	5.8	6.2	6.9	7.5	8.1	8.7	9.2	9.6	10.1	10.5	10.8	11.2	11.2	11.3	11.3	11.2	10.9	10.8	10.1	9.6	9.1	8.2	7.4	6.7
8	5.3	6.1	7.	7.8	8.4	9.1	9.8	10.3	10.8	11.4	11.8	12.2	12.6	12.7	12.8	12.8	12.7	12.5	12.4	11.7	11.1	10.6	9.6	8.6	7.8
9	5.8	6.7	7.6	8.5	9.3	10.1	10.8	11.5	12.1	12.7	13.2	13.7	14.1	14.3	14.4	14.5	14.4	14.2	14.	13.4	12.8	12.2	11.1	10.1	9.1
10	6.3	7.3	8.3	9.3	10.2	11.	11.8	12.6	13.3	14.	14.5	15.1	15.6	15.8	16.	16.1	16.	15.8	15.7	15.	14.4	13.8	12.6	11.5	10.4
11	6.8	7.9	9.	10.	11.	11.9	12.8	13.6	14.5	15.3	15.8	16.5	17.1	17.3	17.5	17.7	17.6	17.5	17.4	16.7	16.1	15.4	14.2	13.	11.8
12	7.3	8.5	9.7	10.7	11.8	12.8	13.8	14.7	15.6	16.5	17.1	17.8	18.5	18.7	19.	19.3	19.2	19.2	19.1	18.4	17.8	17.2	15.8	14.5	13.3
13	7.8	9.1	10.2	11.5	12.6	13.7	14.7	15.7	16.7	17.6	18.4	19.2	20.	20.3	20.6	21.	21.	21.	21.	20.2	19.6	19.	17.5	16.2	14.8
14	8.2	9.6	10.8	12.2	13.7	14.5	15.6	16.7	17.7	18.7	19.6	20.5	21.3	21.8	22.2	22.7	22.7	22.7	22.7	22.	21.4	20.8	19.2	17.8	16.4
15	8.7	10.1	11.9	12.8	14.1	15.3	16.5	17.7	18.8	19.8	20.8	21.7	22.6	23.9	23.8	24.3	24.4	24.5	24.5	23.9	23.3	22.6	21.1	19.6	18.
16	9.2	10.6	12.	13.4	14.8	16.1	17.5	18.7	19.8	20.9	22.	23.	24.	24.	25.3	26.	26.1	26.2	26.3	25.8	25.2	24.5	23.	21.4	19.9
17	9.6	11.1	12.5	14.	15.4	15.4	18.2	19.6	20.8	22.	23.2	24.3	25.4	25.7	26.8	27.5	27.7	28.0	28.1	27.7	27.2	26.6	25.	23.5	21.8
18	9.7	11.5	13.	14.6	16.	14.6	19.	20.4	21.7	23.1	24.3	25.5	26.7	27.4	28.2	29.	29.3	29.1	30.	29.6	29.1	28.7	27.	25.5	23.8
19	10.2	11.9	13.5	15.1	16.7	16.8	19.9	21.2	22.7	24.1	25.4	26.7	27.9	28.7	29.6	30.5	31.	31.4	31.8	31.5	31.1	30.8	29.1	27.6	25.9
20	10.7	12.3	14.	15.7	17.3	18.9	20.6	22.	23.6	25.	26.4	27.8	29.1	30.1	31.1	32.1	32.6	33.1	33.6	33.4	33.1	32.9	31.2	29.6	28.1
21	11.	12.7	14.4	16.3	18.	19.7	21.4	22.9	24.5	26.	27.4	28.9	30.3	31.4	32.5	33.6	34.2	34.1	35.4	35.3	35.1	35.	33.5	32.	30.5
22	11.3	13.	14.8	16.8	18.6	20.4	22.1	23.8	25.3	27.	28.4	30.	31.5	32.7	33.9	35.1	35.8	36.6	37.2	37.2	37.1	37.1	35.8	34.2	33.

TABLE I.—38 KNOTS TORPEDO.

Speed of Enemy.	The Angle of Impact.																								
	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°	120°	125°	130°	135°	140°	145°	150°
6	4.	4.6	5.1	5.8	6.2	6.8	7.3	7.7	8.1	8.4	8.8	9.1	9.4	9.4	9.3	9.2	9.1	8.8	8.5	8.1	7.6	7.2	6.5	5.8	5.2
7	4.6	5.3	5.9	6.5	7.1	7.7	8.3	8.8	9.2	9.7	10.1	10.4	10.7	10.8	10.8	10.7	10.6	10.3	10.	9.6	9.1	8.6	7.9	7.	6.3
8	5.1	5.9	6.6	7.3	8.	8.6	9.3	9.8	10.3	10.9	11.3	11.7	12.1	12.1	12.2	12.2	12.	11.8	11.5	11.	10.5	10.	9.3	8.2	7.2
9	5.6	6.5	7.3	8.1	8.9	9·6	10.3	10.9	11.5	12.1	12.6	13.1	13.4	13.6	13.7	13.7	13.6	13.4	13.1	12.5	12.	11.4	10.6	9.5	8.5
10	6.1	7.	8.	8.9	9.7	10.5	11.3	12.	12.7	13.3	13.9	14.4	14.8	15.	15.2	15.3	15.1	14.9	14.7	14.	13.5	13.	11.8	10.7	9.7
11	6.6	7.6	8.6	9.6	10.5	11.4	12.3	13.1	13.9	14.5	15.2	15.7	16.2	16.4	16.7	16.8	16.7	16.5	16.4	15.7	15.1	14.5	13.2	12.2	11.
12	7.1	8.1	9.2	10.3	11.3	12.3	13.3	14.1	15.	15.7	16.4	17.	17.6	17.8	18.1	18.3	18.2	18.1	18.	17.4	16.7	16.	14.8	13.6	12.3
13	7.5	8.6	9.4	11.	12.1	13.1	14.1	15.1	16.	16.8	17.6	18.3	18.8	19.3	19.6	19.8	19.9	19.9	19.8	19.2	18.4	17.6	16.3	15.1	13.7
14	7.9	9.2	10.5	11.7	12.8	13.9	15.	16.	17.	17.9	18.7	19.6	20.2	20.7	21.	21.4	21.5	21.6	21.6	20.9	20.1	19.3	17.8	16.5	15.1
15	8.4	9.7	11.	12.3	13.5	14.7	15.9	17.	18.	19.	19.9	20.8	21.6	22.0	22.5	23.	23.1	23.2	23.3	22.6	22.4	21.1	19.6	18.2	16.6
16	8.8	10.2	11.5	12.9	14.2	15.5	16.8	17.9	19.	20.1	21.	22.	22.9	23.4	24.	24.5	24.7	24.8	25.	24.3	24.6	23.	21.4	19.8	18.4
17	9.2	10.6	12.	13.4	14.8	16.2	17.6	18.8	20.	21.1	22.1	23.2	24.2	24.8	25.4	26.	26.2	26.5	26.8	26.1	25.5	25.	23.3	21.7	20.
18	9.5	11.	12.5	14.	15.4	16.9	18.3	19.6	20.9	22.2	23.3	24.4	25.5	26.1	26.8	27.6	27.9	28·2	28.4	27.9	26.4	26.9	25.2	23.6	21.8
19	9.9	11.5	13.	14.6	16.	17.6	19.	20.4	21.8	23.1	24.2	25.5	26.6	27.4	28.2	29.1	29.3	29.7	30.	29.7	28.7	28.8	27.1	25.5	23.8
20	10.2	11.9	13.5	15.2	16.6	18.2	19.8	21.2	22.6	24.1	25.2	26.5	27.8	28.7	29.6	30.5	30.8	31.2	31.8	31.4	31.	30.7	29.	27.4	25.8
21	10.6	12.3	13.9	15.7	17.4	19.4	20.5	22.1	23.5	25.	26.2	27.6	28.9	29.9	30.9	31.9	32.4	32.9	33.6	33.3	33.	32.7	31.1	29.6	28.
22	10.9	12.6	14.3	16.3	18.3	20.6	21.3	22.9	24.4	26.	27.2	28.7	30.	31.1	32.2	33.3	34.	34.6	35.2	35.1	35.	34.8	33.2	31.7	30.3

TABLE II.—ERROR IN m. PER 1°'s ERROR OF THE ANGLE OF AIMING, WHEN DISTANCE = 100 m.

The Speed of the Torpedo. Knots.	The Speed of the Enemy. Knots.	The Angle of Impact.												
		30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°
26	6–11	6.2	4.4	3.4	3.2	2.5	2.2	1.9	1.8	1.7	1.5	1.6	1.7	2.
	11–16	7.4	5.7	4.7	3.6	3.	2.6	2.1	1.9	1.7	1.5	1.5	1.3	1.3
	16–22	9.2	7.4	5.6	4.5	3.8	3.1	2.5	2.2	1.9	1.6	1.4	1.1	0.9
28	6–11	5.8	4.2	3.2	2.8	2.4	2.2	1.9	1.8	1.7	1.6	1.6	1.7	2.1
	11–16	7.2	5.4	4.5	3.4	2.8	2.5	2.1	1.9	1.7	1.6	1.4	1.3	1.3
	16–22	9.	7.	5.3	4.4	3.6	3.	2.5	2.2	1.9	1.6	1.4	1.1	1.1
30	6–11	5.6	4.	3.2	2.8	2.3	2.1	1.9	1.8	1.7	1.6	1.7	1.8	2.1
	11–16	7.	5.1	4.2	3.2	2.8	2.5	2.1	1.9	1.7	1.6	1.5	1.5	1.5
	16–22	8.6	6.7	5.1	4.3	3.4	2.8	2.5	2.	1.9	1.5	1.3	1.2	1.1
32	6–11	5.4	3.8	3.2	2.8	2.3	2.1	1.9	1.8	1.7	1.6	1.7	1.8	2.1
	11–16	6.7	4.5	4.	3.1	2.7	2.4	2.1	1.9	1.7	1.5	1.5	1.5	1.6
	16–22	8.2	5.4	4.7	4.	3.2	2.7	2.3	2.	1.8	1.5	1.4	1.2	1.3
34	6–11	5.3	3.9	3.1	2.7	2.3	2.1	1.9	1.8	1.7	1.6	1.7	1.8	2.2
	11–16	6.4	4.1	3.9	3.	2.7	2.3	2.	1.8	1.7	1.6	1.5	1.6	1.8
	16–22	8.	5.7	4.5	3.9	3.1	2.6	2.3	2.	1.7	1.5	1.4	1.3	1.3
36	6–11	5.2	3.9	3.1	2.7	2.3	2.1	1.9	1.8	1.7	1.7	1.7	1.9	2.2
	11–16	6.2	4.3	3.7	3.	2.7	2.3	2.	1.8	1.7	1.6	1.5	1.6	1.8
	16–22	7.8	5.7	4.3	3.7	3.	2.6	2.2	2.	1.7	1.5	1.4	1.3	1.3
38	6–11	5.1	3.8	3.1	2.6	2.3	2.1	1.9	1.8	1.7	1.7	1.7	1.9	2.2
	11–16	6.	4.6	3.6	3.	2.6	2.3	2.	1.8	1.7	1.5	1.5	1.6	1.8
	16–22	7.6	5.7	3.9	3.5	2.9	2.6	2.2	1.9	1.7	1.5	1.4	1.3	1.3

In this table the *distance* means: *the distance that the torpedo must run before hitting.*

TABLE III.—Factor by which the measured or reckoned distance is to be multiplied to give the distance of the torpedo.

The Angle of Aiming.	The Angle of Impact.								
	30°	45°	60°	75°	90°	105°	120°	135°	150°
5°	0.8	0.9	0.9	1.	1.	1.	1.05	1.1	1.15
10°	0.7	0.8	0.85	0.95	1.	1.05	1.1	1.15	1.25
15°	0.5	0.7	0.8	0.9	0.95	1.05	1.1	1.2	1.4
20°		0.6	0.75	0.85	0.95	1.	1.15	1.25	1.5
25°			0.7	0.8	0.9	1.	1.15	1.35	1.65
30°			0.6	0.75	0.85	0.95	1.15	1.4	1.8
35°				0.7	0.8	0.95	1.15	1.4	1.85
40°					0.75	0.9	1.15	1.4	1.9
45°						0.85	1.15	1.4	2.
50°							1.1	1.4	2.
55°								1.4	2.
60°									2.

SCHEME FOR TORPEDO-TRAINING.

Distance, m.			The Distance of the Torpedo, m.	Speed of the Enemy. Knots.			The Angle of Aiming			The Angle of Bearing.	The Angle of Impact.			Hit: Ahead + Astern − m.	Manœuvre.
Reckoned.	Measured.	Error.		Reckoned.	True.	Error.	Reckoned.	True.	Error.		Reckoned.	True.	Error.		
500	525	− 25	475	12	12	0	19.3°	19.3°	0	55.7°	75°	75°	0	0	
450	500	− 110	475	15	12	+3	23°	19.3°	+3.7°	52°	75°	75°	0	+49.2	
600	560	+40	475	12	12	0	23°	19.3°	+3.7°	52°	105°	75°	+30°	+49.2	
650	560	+90	475	19	12	+7	23°	19.3°	+3.7°	52°	62.5°	75°	−12.5°	+49.2	

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ESTIMATING DISTANCES.

By COMMANDER WILLIAM H. BEEHLER, U. S. Navy.

The naval officer in command of a battleship in a squadron has no problem of greater importance in the evolutions of naval tactics or at target practice than the determination of the distances of other vessels in the fleet for the distance of the target.

The inventive genius of the navy has devoted itself to inventions for determining distances, ranges &c., and some of these instruments are admirable, but none are at all times perfectly reliable. Fiske's stadimeter is an excellent instrument, his range finder has also in practice under favorable conditions proven to be very good, but for target practice the gun itself is generally conceded to be the best range finder. But in practice and especially in a naval engagement these instruments and means will not always be available and therefore every contribution to the subject of range finding or estimating distances should be diligently considered and practiced for successfully executing manœuvres and conducting target practice.

When executive officer of the U. S. S. Montgomery under the command of Captain George A. Converse (at present rear-admiral and chief of bureau of ordnance) the writer was directed to carry out exercises for estimating distances. The captain sent the navigator out in the steam launch with a stadimeter to go to varying distances of from 2000 to 4000 yards. Upon arrival at predetermined distances the captain required the executive and divisional officers to estimate the distance of the steam launch. Gun pointers and sharpshooters were likewise all required to secretly report their several estimates of the distances of the steam launch. When this was first tried the estimates by different offi-

cers and men varied as much as 500 yards, but after a little practice the variations differed by less than 50 yards and a large percentage of the estimates were very close. This exercise was another evidence of the fact that practice makes perfect, and the great improvement in our target practice demonstrates this most forcibly. The terrible disaster recently experienced on board the Missouri is greatly to be deplored but notwithstanding the appalling risks, the necessity for such target practice is too urgent to permit us to entertain the thought of restricting target practice.

The advantages of this practice of the Montgomery at Pensacola before the war bore good fruit, subsequently in the destruction of Fort Canuelo at the bombardment of Puerto Rico, May 12th, 1898, where the Montgomery threw 314 5-inch shell from six 5-inch guns in a period of exactly five minutes, at the end of which time there was nothing left of that fort.

While in command of the U. S. S. Monterey in the Asiatic fleet last year (1903) the writer adopted a simple method of estimating distances by which officers and men became very expert is estimating distances very accurately.

This method consists of getting two lines of sight, one with the right eye and the other with the left eye. The observer simply sights with his right eye along the right forearm extended to its full extent and pointing with the right forefinger at the distant object. He then closes the right eye and sights with the left eye, holding the right arm and head rigid as before. In this case the second or left-eye line sight will point to the right of the object first sighted with the right eye, a distance equal to one-tenth of the distance that the said object is from the pointing finger of the observer's right hand. These two lines of sight intersect at the point of the forefinger of the right hand, and with lines, joining the two eyes and lines joining the object with the point to which the left-eye line of sight shall have moved to the right, form two right-angled triangles which are opposite and similar.

The eyes are normally 2.75 inches apart and the right forearm fully extended will bring the point of the right forefinger 27.5 inches from the right eye; the proportion of 10 to 1 exists between the base and altitude of the smaller right-angled triangle, and the same proportion exists between the larger triangle in which the base is the estimated distance that the left-eye line of sight shall have moved to the right of the object and the altitude

is the distance of the object from the intersection of these two right-angled triangles.

An example of the practical use of this method will be clearly understood. While at Chefoo the Monterey was required to take position 300 yards from the Monadnock. The Monadnock was 55.5 feet beam and when directly astern of the Monadnock observer pointed at the mast of the Monadnock and observed that the left-eye line of sight moved to the right a distance equal to a beam and a half of the Monadnock, a distance equal to 55.5 feet plus 27.75 or 83.25 feet, making the distance of the Monadnock 832.5 feet. By pointing to the port edge of the after turret of the Monadnock, a point just 34.5 feet from the edge of the starboard rail at its greatest midship section, the distance was found to be 900 feet when the left-eye line of sight pointed to the right at a distance such that the Monadnock might just fill the space between that point and the position of her starboard rail, a distance of 90 feet. It was required that the Monterey should be 300 yards or 900 feet from the Monadnock and every officer and man on board could at any time determine the distance.

The distance which the left-eye line of sight moves to the right of the previously observed line of sight with the right eye, is only an estimate and if that estimate is erroneous the distance will have been estimated thereby with an error ten times that of the first estimated lateral displacement. If this lateral error amounts to 10 yards the estimated distance will be 100 yards in error, but such an error will not be realized by those who are expert in this method. A little practice, especially in observing distances of objects of known dimensions will make the error in the estimated lateral displacement of the left-eye line of sight very small, much less than a foot, and therefore invariably give the distance within 5 or 6 feet of the true distance, even when the object, such as a steamer at sea may be 2 or 3 miles distant.

A necessary corollary of this is that the length of a ship or any other object at a known, or previously determined distance, will also be given by observing the estimated lateral displacement of the left-eye line of sight and giving the estimated length of that object (for example, if a ship when broadside on) as one-tenth of her distance from observer.

This method of observing and estimating distances was used on board the Monterey while under the writer's command on the

Asiatic station every day at setting up drill at morning and evening quarters. Divisional officers then required the men to estimate the distances of vessels in the harbor taking advantage of knowledge of the length and beam of the ships or of boats near by as might offer.

This method is not altogether limited to determine distances during daylight but with range lights at say, 300 feet apart when broadside on, the distance of the range lights from the observer might be very accurately determined at, say 1500 yards, when the lateral displacement of the left-eye line of sight should happen to be exactly one-half the distance between the lights.

While estimating distances on board the Monterey by the method used by Captain Converse it was found that the estimates of distances differed widely under different conditions of the atmosphere, whether hazy or in bright sunlight, but this method of the right and left-eye lines of sight will be found by practice to be quite independent of atmospheric conditions. The method is manifestly always available, a stadimeter may be left below, or out of adjustment, or otherwise not available, but every officer and man will always appear with his eyes and arms and intelligent use will by practice make him more or less independent of instruments. The gun is claimed to be the best range finder, but in an engagement it may and probably will be often impossible to determine where the shell from your gun struck, if other ships and guns are firing at the same time, and the writer knows of no instrument that can be depended upon to meet all the requirements that will arise in a naval engagement. This method is therefore earnestly commended as a most valuable aid for successfully carrying out manœuvres in naval tactics and in target practice.

Since officers and men are not all uniform in size it is evident that the distance of the end of the right forefinger with the right arm fully extended in front of the right eye from the right eye, is not always exactly 27.5 inches, neither is the distance between the two eyes always exactly 2.75 inches; but the ratio between those two distances of ten to one always is or can be made to be the same. This ratio will have to be determined for each and every individual, and in case practical experiment should show this ratio to be wrong, the individual can readily make this ratio, either by prolonging the point of intersection of the two triangles

by means of a lead pencil in case the ratio of the length of forearm and distance between the eyes is less than ten to one, or by using the thumb as pointer in case the ratio is greater than ten to one. The proportion of ten to one is the most convenient factor to use and each individual should be taught to ascertain his own personal range-finding ratio for estimating distances by two lines of sight from the right and left eyes.

In many scientific discussions on range finding it is the fashion to regard all mere estimates of distances as utterly unreliable, but estimates and good judgment are required even when using the accurate instruments of precision, and observers are required to depend upon their estimates of coinciding reflected images, etc. In the most scientific range finder which the writer has ever used, viz.: Carl Zeiss stereoscopic range finder, in which the stereoscopic plastic or depth of perspective is the principle, the observer is called on to estimate when the image of the distant object appears to be at the same perspective depth as certain figures on a scale blending into the perspective view of that distant object. Here good judgment is a requisite and observer must have two eyes of equally good visual power. It is therefore absurd to ridicule methods of estimating distances.

Careless observations of distances by this simple method of the two lines of sight with right and left eyes will never give reliable results. This method though simple requires rigid compliance with its conditions. The right forearm must be fully extended and directly in front of the right eye. When the right eye is closed and the left eye line of sight used the observer must be very careful to keep his arm and his head exactly in the same position, the very slightest deviation will cause a great error and vitiate the predetermined ratio of the distance between the eyes and the distance of the end of the index finger from the right eye. Again the observer must be extremely careful that the two triangles formed by the intersection of the right-eye and left-eye lines of sight are strictly right-angled triangles, and also that the point of the lateral displacement of the left-eye line of sight to the right of the object is a point in a line parallel with the line between the eyes or at right angles to the right-eye line of sight.

Again, in estimating distances by using known values of the length of a ship for instance, the observer must be sure that the observed ship is broadside on, or if not broadside on he must

make allowance for the way she is heading. It is evident that if the observer is off the starboard quarter of a distant vessel 300 feet long for example, and if his first right-eye line of sight pointed at her stern and his second or left-eye line of sight pointed to her bow, the lateral left-eye line of sight would not have been displaced a distance of 300 feet, but only about 225 feet, and the distance in that case would be about 2250 feet instead of 3000 feet.

The greatest and in fact the only objection to this method of estimating distances is its simplicity. It is so very simple that few will take the trouble to rigidly adhere to its requirements, but to those who do strictly comply, practice will prove it to be much better than some instruments of precision that claim to be accurate range finders. This method may be said to be never liable to get out of adjustment, but that is not true, for every careless observation, when observer does not have his arm properly extended directly in front of the right eye or should move his arm or his head between the observations of both eyes, may be designated as being out of adjustment.

It is earnestly hoped that the naval service will take up this method and require every officer and man to practice it at every opportunity. It is always available, requires no apparatus and costs nothing but strict practice. But correct estimates will only be obtained by strictly adhering to the requirements. It is so easy that it is difficult to comply with its strict requirements.

The writer had the tops of the turrets marked with white lines as a dumb compass that facilitated taking bearings of distant objects from the bridges, that proved to be a very decided aid in estimating distances.

To insure accuracy in estimating distances it is advisable for divisional officers to have a right angle triangle constructed of light battens of dimensions such as to simulate the observer's small right angled triangle—

The base may have a small groove to fit over the nose. Then closing left eye observe along the edge with right eye, sighting on distant objects. Then close the right eye and sight along the hypothenuse with left eye and estimate how far the left-eye line of sight points to the right of the object first sighted.

DISCUSSION.

"THE FLEET AND ITS PERSONNEL." (See No. 109.)

Rear Admiral C. F. GOODRICH.—It is impossible to read the two essays which open the thirtieth volume of the PROCEEDINGS OF THE NAVAL INSTITUTE without being forcibly impressed by the radical differences they present. In matter, in manner, in motive, they are as remote as the poles. The one appeals to a large and enthusiastic body of officers, the other to a number, doubtless smaller but none the less devoted, heart and soul, to the good of the service, whose modes of thought are more conservative and who are influenced not so much by the reaching after highness for bigness' sake as by the gravity of the responsibility which rests upon us all to do faithfully and untiringly whatever lies within our own powers to improve the tone of the Navy and to multiply its efficiency in all respects and in every branch. The striking contrast between these two essays, of which one has been awarded the Institute's gold medal for the year 1904, and the other has received an honorable mention, furnishes a criterion by which their readers will divide themselves naturally into the two groups I have indicated. Frankly speaking, I am at a loss to understand why the palm of superiority should have been awarded to an essay which with one trivial exception appears to be lacking in originality, which adds little to our knowledge of ourselves and which repeats for the hundredth time the cry for more ships without explaining why more ships are needed; as against a notable contribution to the practical ethics of the profession. The latter tells us unpleasant yet salutary things in so logical a manner that, squirm as we may, we shall never again be able to sin in ignorance of a duty laid down in clear and unmistakable terms. Personally, I should rather encourage those who show us how we may make better use of the material we already possess than the counsellors of a perfection which is dependent upon the vicissitudes of external legislation.

The prize essayist says "We want our fleet to be such a power as the world has never seen." This proposition may be true and—it may be false. Expounded by the essayist, it calls for a total of no less than sixty armored vessels, nearly a million tons of displacement, and the expenditure of a corresponding amount of the taxpayer's money. The world at large, the public which has to provide the funds, however willing and ready to disburse generously, is surely entitled to a discussion of the reasons for the outlay. Some there be who need no convincing. Doubtless the makers of steel and the anxious owners of idle shipyards would think the essayist very moderate—too moderate—in his demands, but if this increase is necessary why not turn the light of historical analysis upon the problem and scatter the darkness and the cobwebs which obscure the doubter's mind? Not to produce this calm and critical dissecting of the past as the basis upon which a wise forethought may build for the future is to quit the domain of philosophy and lose one's self in the maze of prophecy. Now

prophet for prophet which is the more to be trusted when each proclaim the other a deceiving and misguided soothsayer? If one says sixty; another, one hundred; and a third, twenty armored ships, all three can not be right. Where is the touchstone by which we may know truth from error? It was incumbent upon the prize essayist to lay his foundations broad and deep so that none could criticise adversely before erecting his bulky framework of naval material and naval organization on a *petitio principii*.

Understand me, I do not say that such a colossal navy is not necessary now, or that it will not soon be necessary. I only ask the essayist, for goodness' sake, to tell us why we should be content with sixty armored ships in 1912. He *must* know, since no doubts cluster around his pen. If he will but lay before the world the results of the painstaking investigation, which have led him to adopt this particular figure and prove by the teachings of history (which Daniel Webster truly said was the only lamp to illumine our path) he will confer an enduring benefit upon the Navy, which is unkindly thought by some sharped tongued cynics not to know what it wants or why it wants it. I beg him to break a lance for the service in the forum of public opinion.

On one detail I am hopelessly at variance with the prize essayist and all who share his views. Any one who advocates a 3500-ton 25-knot scout displays complete ignorance, both theoretical and practical, of the subject of scouting. Let the essayist give the reason for the faith which is in him for upon him rests the *onus probandi*.

The essayist remarks relative to the personnel are sensible, pertinent and for the most part trite. With them as a whole only the most captious could quarrel—yet one rises from their perusal little if any wiser than before—however much one may be charmed by the delightful English in which they are framed and which stamps the writer as exceptionally gifted. I cannot avoid the suspicion that this manifest superiority of style turned the scale against the better essay.

Contrast the broad generalities of the prize essay with the concrete objects laid down by Dr. Ames. "So if I can, in my feeble attempt, show that an injury is being done, then I feel that you will aid in correcting the evil. This, I will now attempt to prove," and he then proceeds to make his case clear and to define the obligations which this demonstration imposes. Whether we agree or disagree with Mr. Fullinwider is immaterial, for the theme is chiefly academic and consent entails no duty—but we cannot accept Dr. Ames' views without feeling our service conscience stirred until it pricks us into action.

To his suggestion I make but one addition, the renewal of a recommendation of long ago, that officers coming up for promotion should be subjected to a "dynamic test," commensurate with their new duties. To promote a man to the grade of Lieutenant who cannot keep abreast of his men as they go at double quick up a slope is worse than folly—it may pave the way to a national disaster. Ancient captains and rear-admirals may properly be allowed a certain generosity of waist measurement, but officers below these grades should be encouraged to cultivate the manly beauty of the full chest and the restrained paunch under peril of being plucked.

If, in this discussion, I have spoken with unaccustomed directness it was not to the end of destructive criticism or without recognizing both the possibility and the propriety of a point of view entirely different from my own. Unless there were various schools and modes of thought these Proceedings might embalm history but they would be void of discussion. So I have tossed this apple into the ring that he who picks it up may explain not that, in my comparison of the two great essays of the year, I am wrong (which is very likely, for I am very often wrong, a fact which interests nobody), but *why* I am wrong—another matter altogether, which reaches to the very core of the question.

I think Dr. Ames may congratulate himself upon the realization of the wish contained in his final sentence "If I succeed in arresting attention, or secure a single advance in improving either the moral, physical, or intellectual standard of our naval personnel, I shall feel that my labor has not been in vain." The navy can never be again what it was before the publication of his essay.

Captain F. J. DRAKE, U. S. Navy.—Lieutenant Fullinwider is to be congratulated in having selected the most important subject effecting the vital interests of the service.

He strikes the keynote when he states that "The Navy requires the most perfect organization and administration."

The history of all large corporations points to the fact that their success depends absolutely upon the perfection reached in the details of their system.

Every technicality and contingent has been worked out, so that they are able to meet all emergencies without disturbing the harmony of the organization. The result is, success and capacity to encounter and overcome all obstacles without bringing any undue tax upon any particular branch or arm of the system.

The same necessarily applies to all military or naval organizations.

The lack of systematic organization leads to the development of eccentricities on one line of action, thereby losing sight of the fundamental principles of the development of a harmonious whole.

The result is the abnormal production of one feature in the organization which is held up to the public as highest efficiency, while we labor under the delusion that it could not be reached unless the details of the whole organization had been equally perfect. A fictitious security which might lead to defeat and destruction in a prolonged struggle, or series of reverses.

Take for example the development of the gun-pointer, in which every other feature of the organization is made subservient, in order that he may score the greatest number of hits per calibre of gun within an accepted period of time. It must be acknowledged by the majority that this wins battles and is not only significant of a high degree of fighting efficiency, but leads to the conclusion that such efficiency can only be reached through a complete organization.

The highest proficiency of the expert gun-pointer is reached when the

supply of ammunition is more than equal to the gun-pointer's capacity to place a maximum number of shots in the target in a given interval of time.

This fighting feature of the organization does not extend outside of supply and demand in gun drill for main and secondary batteries, and is now tending to abnormal development like the muscle of the pitcher's arm in a base ball nine. The latter is the effective force which makes up for many difficiencies and weaknesses in the team. His capacity to deliver swift and curved balls over the plate is paramount to all other requirements. To be sure the catcher, basemen and short stops in the different league teams have their degrees of proficiency, but the main success of an individual team is dependent upon its pitcher and catcher. It is, however, invariably found that the winning team is the one which not only has an expert pitcher, but that catcher, basemen, short stop and field are all excellent players. Moreover, the team, as a whole, is well organized and thoroughly drilled in every feature of the play, insomuch that any emergency which may arise during the play (by which one of its number is crippled) is immediately provided for, and the play goes on without weakening the efficiency of the team.

This principle applies to every man-of-war, and emphasizes the necessity for a complete standard organization of the personnel for all types of vessels in their respective classes and ratings, and thus obliterate from our navy the present heterogeneous system, devoid of many standard principles and virtually depending upon individual officers, no two of whom will practically conceive or develop any organization on the same lines for the same type of vessel in any class or rate; thereby defeating the object sought, namely: a complete and systematically developed organization of the enlisted personnel, which is capable of harmonious expansion or contraction on the same base for all types of vessels.

Then would the present confusion, disgust and lack of interest shown among the enlisted personnel which is due to our want of a progressive and systematically developed organization, disappear, as the instructions given on one ship for any particular station or billet in any of the evolutions would not only hold good for that station, on any other ship, but if advanced in rate or type from a smaller to a larger vessel, it would then be progressive in the development, reaching to the next higher station.

The fault of our present system is due to the condition of our administrative policy which makes it appear as if it had lost sight of the fundamental principles which lead to success in all great organizations, i. e., that the keystone of the arch can not be placed until the structure shall have been completed in all of the details of a solid and substantial base.

Therefore, the officers afloat in the service cannot be expected to perfect an organization, unless the administrative power takes such action as will develop the base in all of its details, making such radical changes as the present evolution of the entire service requires. We have the necessary talent for this development, but are primarily restrained by want of legislative action, which is not in accord with the energy, zeal and

loyalty which is displayed throughout the service, when the personnel has its best interests at heart.

The initiative must be taken by the administrative head to establish such an organization; and this can only be accomplished through the assistance of a general staff, composed of officers who have been schooled in all of the details and requirements of modern warfare. Hence, if the navy is to be brought up to the highest degree of fighting efficiency, immediate action should be taken through legislation to create a general staff for that purpose and the general administrative policy.

The scope of the general staff to be defined in its essential features, as far as its primary decisions would effect the present bureau system.

In the beginning, the Atlantic, Pacific and Asiatic squadrons, as outlined by Lieutenant Fullinwider, would form a base for developing a substantial and permanent system of squadrons of the battleship and cruiser class, having alternating periods of at least two years on each station.

This would enable the commander-in-chief and commanding officers of the fleet to become sufficiently acquainted with the political and commercial features of the country within the limits of their station, to meet any emergency which might arise, thereby best guarding the advancement of our commercial relations, while maintaining the necessary friendly relations between nations.

The enlisted force to serve their first two years on one station and the second two years on the next station, in the order of the transfer of squadrons decided upon. The entire enlistment to be in ships belonging to the same squadron. At the end of the first two years there should be a transfer of men between these ships; so many boatswain's mates, coxswains, seamen, ordinary and apprentice seamen (landsmen) being transferred from the battleship or battle-cruiser class to the smaller cruisers and gunboats, the latter crews going to the larger vessels. By this system the crew, in one enlistment of four years, becomes familiar with his duties in the different types of vessels in the squadron and has had the satisfaction of serving his enlistment on two stations, with the knowledge that upon re-enlistment he will go to the next station in the order of transfer, thus making the rounds of the different stations depending upon his continued service.

In the proposed organization and present development of the gun-pointer in vessels of different types and classes in the same squadron, there should be established at once by the department a scale of percentages in the target practice score for each type and class of vessels, so as to compensate the gun-pointer in the obsolete type, for the increased mechanical efficiency in modern vessels, whether it be battleship, battle-cruiser, cruiser, coast defense, gunboat or auxiliary.

By this system of percentage scaling, or handicap upon the modern type, which is furnished with the latest mechanical appliances in guns, mounts, etc., it will be possible to show the percentage of hits which would have been made by the gun-pointer in the obsolete type, had he been firing with the most improved guns and mounts.

By knowing that he has this percentage in his favor, the gun-pointer,

as well as the entire crew, of the obsolete type, will enter into the spirit of practice with that interest and enthusiasm which promotes rivalry and emulation to win the laurels from their more fortunate shipmates in the modern type of vessel.

It is one question to build fighting ships with our unlimited financial resources. It is another and more vital question to man them with a proficient crew having the best organization that nautical talent can produce, in order that their fighting efficiency shall be a maximum at all times.

The question of a "home base" is well taken and possesses the fundamental principles requisite to the proper maintenance of our fleets.

It may be a little more difficult in the beginning to assemble non-perishable stores and outfit for different rates in their respective ships or issuing houses, at the home base, but when once assembled they are more quickly taken on board. The question of their preservation in analogous to the present system of storage under the general storekeeper. All material of a technical nature in ordnance, equipment and steam engineering, should then be transferred to the custody of the respective officers in charge of these departments, in order that their preservation and serviceable condition may be insured at all times, after having been assembled. By this system the work of the several departments concerned would be reduced and less complications exist than under the present method.

With regard to navy yard employees; under the present civil service conditions, there are certain positions which would necessarily be filled by civilians who have had no previous naval training. The identity of an employee who was formerly one of the enlisted personnel very soon merges into that of the civilian who is without any previous naval training, owing to the environment and influences which exist outside of a naval life.

It would be of great benefit to the service, as well as to the government, could the system proposed by Lieutenant Fullinwider be carried out, and thus have employees retain their naval associations and influences by remaining in the service and be eligible for civil service employment on navy yards. It is significant, however, that opposition to this method would appear in the political field.

It is noteworthy that such a system holds out inducements to the enlisted men and insures continued service afloat, which, after three or four enlistments entitles him to shore duty and permanent employment. The latter, however, should depend upon his average conduct record while afloat.

No vessel which is worth retaining on the active list should be laid up in ordinary. Cruising repairs should be made on the station and each fleet should be accompanied by a repair ship, capable of undertaking any ordinary work.

This should keep vessels in efficient condition for two years or the period on any one station.

Such general overhauling as may then be necessary could be accomplished at one of the home bases which Lieutenant Fullinwider has suggested, connected with either Atlantic, Pacific or Asiatic station. These three

stations, being provided with a home base, would also be able to meet all emergencies on the South Pacific, Atlantic or European stations.

In the building programme, that policy should be followed which would keep the battleships, armored cruisers, cruisers and smaller vessels up to the necessary number and latest type, as the expanding interests of our commercial relations and necessary naval protection require.

It should be possible for the general staff to outline this development on a uniform and substantial base with the data now at hand relating to our expanding possessions, and growing commercial interest within the last seven years.

Our interstate development and unlimited resources for supplying a rapidly expanding manufacturing interest, has culminated in forcing us without the bounds of our original conservative policy and we are now compelled to seek the markets of the world for surplus products.

Hence, the necessity for a navy maximum efficiency, capable of guarding and protecting these interests at all times. Otherwise we must cease to exist as an important commercial factor in the world, thereby increasing our indebtedness while other nations define our financial policy.

I do not consider the present apprentice system a success. It may well be compared to a hatchery in which large numbers constitute the embryonic stage, whereas but few reach the age of maturity and become living examples of its success. This is fast being absorbed by the "Landsmen for Training" system, which, when properly developed in all of its details, will form the only nucleus on which we can expand our enlisted force and maintain it on a substantial base. Lieutenant Fullinwider has outlined the principle steps necessary in the right direction.

This is the most important feature of the service, and the responsibility for its efficient development in all of its details, cannot be avoided by the administrative head, and the general staff or board, should be brought face to face with the issue and be empowered to act without unnecessary delay. Hence, the immediate necessity for legislative action, whereby this important feature of naval administration shall become a law, in order that, "The Fleet and its Personnel" may be put on a substantial, progressive and efficient fighting base; otherwise we must look for defeat and failure, and cease to be recognized as a world power.

Commander E. B. BARRY, U. S. Navy.—Patrick Henry in one of his eloquent speeches says: "It is natural for man to indulge in the delusions of hope." After reading this admirable essay on the fleet and its personnel, this is the first thought presented to my mind. Would that Lieutenant Fullinwider's wishes, ideas and hopes could be realized. Must we dream or must we accept what we face and do the best with what we are allowed?

The history of the United States as affecting the navy through public opinion and legislation has been divided into periods of neglect and apathy, separated by hysterical enthusiasm and legislative support, rising suddenly to fever heat and then gradually dying away into the old apathetic rut. History also shows that one of the time worn arguments against improving or strengthening the navy has been the danger of placing at the

disposal of the executive a powerful weapon available for war, aggression, or conquest. Indeed, more than once references to Charles I of England, and doubts but that he is living in the United States either in the flesh or in the spirit, have emanated from people that ought to know better, high in the councils of the nation.

I fear the naval wave raised by the war with Spain has reached the outer line of shoals and soon will expend itself upon the beach of neglect. Already there are signs pointing towards this condition and against which such essays as the one under discussion are indirect protests.

While under enlisted personnel the essayist touches upon the "political, social and economic conditions of the country," he makes no reference to them under the section devoted to the fleet.

To my mind the political and economic conditions, together with the ever powerful non-military and anti-military feeling must be taken into account, as fleet construction and development in the United States are bound up in them and greatly dependent upon them. The question of what is called a naval programme seems to excite grave fears, and many reasons against such a measure are assigned whenever an effort is made to establish one. To the naval mind a construction programme seems the only rational way to build up a navy; but even facts and figures seem to make no impression.

Even as late as 1890 the policy board, so called, presented a rational scheme of naval development that met with cold welcome. It covered a period of fourteen years with a building programme calling for the laying down of 14% the 1st and 2d year; 10% the 3d and 4th years, then 12% each succeeding year. At the end of fourteen years there would have been a naval force of 13 battleships of large coal endurance aggregating 120,450 tons; 25 battleships of limited coal endurance aggregaing 179,200 tons, a number of harbor defense vessels and rams aggregating 62,320 tons and 68 cruisers of all classes aggregating 225,500 tons; added to this was 6565 tons of torpedo boats. This gave a total force, exclusive of harbor defense vessels and rams, of 106 vessels aggregating 525,150 tons and costing, including $44,500,000 for harbor defense vessels and rams, $336,450,000; another total given by the board is $342,950,000 from which is to be deducted $67,965,000 already expended or appropriated; so that this building programme called for an expenditure of $274,085,000 to produce a homogeneous force. Allowing that half of this programme would have been completed in 1898 we then should have had 6 battleships of large coal endurance, 12 battleships of limited coal endurance, and 30 cruisers of all classes, with 3000 tons of torpedo boats, at an expenditure of $137,042,500 for 293,738 tons. Instead of this we had actually available for use a so called fleet embracing every fancy of the naval mind, consisting of 4 "large" battleships, 2 "small" battleships, 2 armored cruisers, 3 monitors, 36 cruisers of all kinds and 6 torpedo boats, aggregating 186,838 tons. This does not include many vessels on our paper list of no fighting value whatever. There were building at that time 5 battleships aggregating 57,625 tons. I have not the data available to give the cost of this collection of vessels, but there had been appropriated

during that period for the navy, exclusive of pay, $259,283,495; which is nearly twice the amount above given by the board.

The total appropriation including pay for the navy from 1883 to 1904 both inclusive has been $760,896,567.

Can any more convincing argument be advanced than that shown by these figures? True it is we are making a better showing now, for there are building 11 battleships in various stages of completion, and 6 appropriated for; 8 armored cruisers building and 2 appropriated for, as well as 3 scout cruisers.

May it be permitted to indulge the hope that the third effort for a building programme may meet with better success?

The essayist strikes the keynote of administrative reform when he says that any plan that will adequately serve the desired purpose will decrease the prestige of particular bureaus or officials. Human nature is the same everywhere and until "bureaus or officials" are forced to surrender the power or prestige that should be taken away for the good of the service, officers holding those positions will use every endeavor not only to retain what naval power their positions possess but also to add what it may be possible to acquire.

Conflicting and jarring interests were overcome in the army reorganization, why cannot they be overcome by us?

I fully approve the proposed organization of the present fleet (when it becomes a fleet), it is the best that can be done with it. However, I venture the hope, that a sane naval policy of construction will be well under way by the time these vessels are all in commission.

What we want are *types* and *groups of types*. A group of homogeneous vessels be they a fleet or be they a squadron, is worth more fleet action than a mixed collection of vessels some of which are more powerful than any vessel of the group.

The description of the home base is that of a first class naval dock yard. There can be no doubt we should have several of these bases, sufficiently removed from the coast to be free from bombardment from the ocean, yet on deep water and within less than 200 miles of the sea.

There is so much to be said for or against any scheme of enlisted navy yard labor that pages could be written about it. To me it seems sufficient here to propound the question, what view will be taken of such a condition by the non-enlisted laboring man now employed? Connected with this subject the social and industrial feeling as existing in this country must be reckoned with.

I agree most fully and heartily with the building programme as outlined by the essayist, except that I would begin at once to provide for replacing obsolete and worn out vessels. Numbers do not make a fleet. Imagine fifty old time monitors engaged in battle with twenty modern battleships!

We want to keep our fleet always as nearly up to date as possible. If we make ready to replace obsolete vessels when they are worthless, we shall be three or four years behind in everything. Above all things connected with our new navy, let us avoid paper strength; when a list of vessels is put on paper let it mean availability for service and not that

certain vessels have not yet been sent to the scrap heap—such returns never fool anyone except our own people.

Had the money wasted on naval freaks been expanded for the logical development of our fleet we should have been much stronger to-day in fighting force. Well does Mr. Fullinwider say: "It is a mistake to build ships that have not a real military value, because it is an unnecessary extravagance in money, men and officers."

That part of the essay relating to the enlisted personnel brings up the ever vexing question of recruiting and training for the navy. It all settles down to this: Is it better to give special training to the man or to the boy—the landsmen or the apprentice?

Is the attack on the apprentice system warranted by the results? The essayist says, "As a rule apprentices have not a strong sense of duty and responsibility and it is well known that in proportion to their number they commit far more infractions of law and regulations than any class of men on board ship." If by these infractions are meant the petty boyish pranks boys always will commit, the statement is readily accepted. I venture to remark that probably nearly all of our ex-apprentice warrant officers and petty officers, praised so highly by the essayist, in the past came under this general arraignment? Let us see how the charge applies to some of the graver offenses:—According to the report of the Chief of the Bureau of Navigation for the year ending June 30, 1903, there were 27,245 men and boys in the navy: The total desertions were about 12.5%; there were 6.173 landsmen for training or about 23% and 4538 apprentices or about 16%, in the navy. Of the landsmen for training there were 4355 in general service making 21% of the enlisted force exclusive of apprentices, while their total made, exclusive of apprentices, about 28%. Of apprentices there were 3112 in general service making 15%, exclusive of landsmen for training; while their total made exclusive of landsmen for training, about 21%. There were discharged for bad conduct 485 men and 17 apprentices; at 21%, 6 landsmen for training for every 1 apprentice, and as undesirable, 490 men and 43 apprentices; at 21% 5 landsmen for training for every 2 apprentices, a total of 975 men and 60 apprentices. As the landsmen make up 21% of the men it is but fair to credit them with 21% of these discharges, making 204 landsmen for training discharged for cause against 60 apprentices; almost 7 to 2. There were 3985 desertions of men and 251 of apprentices. Applying the same rule we have 836 desertions of landsmen for training against 251 apprentices; almost 7 to 2 again. For inaptitude, there were discharged 112 landsmen for training against 112 apprentices, which would indicate that it seems harder to judge what an undeveloped boy will become than what a developed man already is! The only wonder is that these last figures are not more unfavorable to the apprentices. Summing up then, we have discharged for bad conduct 6 landsmen for every 1 apprentice; discharged as undesirable, 5 landsmen for every 2 apprentices, averaging 7 landsmen for every 2 apprentices; desertions, about 7 landsmen for every 2 apprentices; in the face of these facts can the essayist insist that what he states is "well known?"

In the report, estimate is given of the number to be trained during the

year, showing 4320 landsmen or 70%, and 1620 apprentices or 35%. This appears to be a discrimination against apprentices, but it is not, as this training is offset by the preliminary training the apprentices received at the training stations. Besides, the landsmen are trained in steamers of the Buffalo class, in droves of 1600 at a time, while 600 apprentices at a time make cruises in the Alliance, Hartford and Monongahela, where they continue the admirable system begun at the training station. The landsmen for training form 23% of the enlisted force while the apprentices form only about 16%. It stands to reason that 32 commissioned officers and 18 warrant officers can do better work with 600 apprentices, 12 boys to one officer, than 46 commissioned officers and 18 warrant officers can do with 1600 landsmen, 21 landsmen to one officer.

The desire for change is swinging the naval pendulum towards the landsmen for training and away from the apprentice. If the training course were carried out consistently and if boys not three months enlisted were not dumped aboard cruising ships there would not be so many complaints about their immaturity and the faults of the apprentice system. If these boys are given their full period of training, and I believe they are now getting it, they will go out into the service ready to do what is expected of them. While on this subject I think it will be a great mistake to raise their age of admission to 18. The vital point of the apprentice system is to get boys young so that their term of enlistment will be long. What an anomoly it will be to enlist two 18 year old boys, and by that mysterious process known only to the recruiting officer, enlist one of them for four years and the other as an apprentice for three years!

During the past year, to show what care has been taken with enlistments, 72% of all men applying for enlistment and 76% of all apprentices have been rejected. This seems to indicate that more care was taken to enlist apprentices than men.

Far from abolishing the apprentice system, I would increase it, but I would not allow anything to interfere with the training course. I would allow no emergency, no matter how pressing, to permit taking any boys from the training service into the general service until they had completed the prescribed course and thus were rendered fit for duty in a cruising ship.

Make it worth while to the apprentice to re-enlist, as certainly I think it now is becoming, and we will continue to recruit our boatswains and gunners and keep them the creditable and able force they have been for so many years.

This is hardly the place to enter into a discussion of our landsmen training system, but I think it wrong from start to finish. What gain can accrue from herding great droves of greenhorns aboard converted merchant steamers and sending them from place to place "seeing the world" and then going home on furlough?

I should not expect too much from the recruit. I should not try to make him into an Admirable Crichton four months after he left the plough. I would give him the preliminary training to be obtained at the naval base and then I would send him into the cruising men-of-war. I never have

been able to grasp the power of intuition possessed by a recruiting officer who assigns with lightning rapidity and perfect accuracy one recruit "for general service" and the next "for training."

I would not promote them through the various grades until reason showed they had served long enough in each grade to acquire knowledge of its duties.

While I agree thoroughly with all the essayist's remarks about the troubles attending enlistment and naval service in America, I cannot but regard them, although not so intended, as arguments in favor of the apprentice service.

Following partially the suggestions of Rear Admiral Wise, I would abolish the titles of landsmen, ordinary seaman and seaman, and substitute for the non-apprentices the titles of seamen 3d, 2d and 1st class.

For the apprentice and the ex-apprentice I would never give up the title identified for so many years in the past and to be identified I hope for many years to come with our corps d'elite.

All honor to our figure of eight knot.

I cannot agree with the age minimum as fixed by the essayist at 18. I would fix, however, the minimum age at 20, except for apprentices whose maximum and minimum age I would fix at 18 and 16 years. I fail to see any warrant either in the past or the future for the abolishment of what he calls the "theoretically perfect" apprentice system.

Whatever may be the practical faults of this system, it has furnished nearly all our warrant boatswains and gunners and all our commissioned officers promoted, as the army would say, "from the ranks." I agree so fully with the rest of the essay, especially that part relating to officers, that I have nothing for it but words of praise.

One paragraph I desire to call particularly to mind and I disagree only with the essayist insomuch that I would make it a matter of legislation that no line officer would be eligible for promotion to the grade of commander unless he had served both as navigator and executive officer of a man-of-war while either a lieutenant or lieutenant-commander. If ordnance officers also were included, although the duties are highly important and should be assigned only to thoroughly qualified specialists, it would work injustice to many deserving officers. I never expect to be called into a professional consultation by a lawyer or surgeon.

I have trespassed already too much on valuable time so I shall end as I began. "Would that Lieutenant Fullinwider's wishes, ideas and hopes could be realized."

Commander BRADLEY A. FISKE, U. S. Navy.—Lieutenant Fullinwider's essay seems to me to declare some important truths which are so simple that we have overlooked them.

This remark applies especially to the causes he suggests for desertions and failures to re-enlist. In our anxiety to find out these causes, we have gone to a lot of work to seek out hidden mysteries, while the real cause has been standing in front of us all the time. This real cause is suggested in Lieutenant Fullinwider's sentence—"The average man looks

forward to the time when he may have a home and family." But it is not only the "average man" who wants a home and family; it is every healthy, normal man. The strongest instinct of human nature is the instinct of self-preservation, and the next is the instinct of procreation. We can shut our eyes to miss, if we wish:—but why shut our eyes?

Therefore, when we invite a man to adopt the naval life, we invite him to adopt a life that is directly the opposite of the kind of life that has been longed for, through instinct, by every healthy, normal man who has ever lived.

Now the reason why a naval man must adopt a life which in one important way is the reverse of the kind of life men like to lead, is the *long and distant absences from home.* Let us admit this fact and all it leads up to; and then we shall have made the first step towards cure, which is a true diagnosis of the disease.

Lieutenant Fullinwider's suggestion of home bases, if it can be carried out in practice, will help this trouble very much; and perhaps it may be to the point if I state that, some years ago, when I was on leave in Europe, I was on board Le Formidable a great deal at intervals, for nearly a year and saw the results of a system somewhat on this plan. Le Formidable was flagship of the French Mediterranean Fleet, and I had the most unusual (if not unprecedented) good fortune to go out in her many times, when the entire fleet was being handled underway. The fleet stayed nearly all the time near Toulon, and went out frequently for drill and then returned to port for rest and recreation. For drill the base was usually Golf Juan, not far away; and from the anchorage there, the fleet would get underway at exactly eight a. m., three times a week, would anchor there at sunset. During this interval, the fleet would exercise continually at fleet maneuvers, and I never have seen such an inspiriting sight as the simultaneous and co-operating movements of those squadrons of battleships, cruisers and torpedo-boats! It was amazing to me; but the cause is not hard to find. That fleet had simply been drilled *as a fleet* continually, and for years. It had not wasted its time and energies on long, aimless, tiresome and exasperating "cruises" in enervating climates, far from home. Its officers and men had been kept alert by the stimulating effect of that proper succession of hard work and hard play that every man needs, if he is really to be alive.

The only point on which I must ask permission to differ with Lieutenant Fullinwider is his suggestion of dividing our fleet into two parts, the Home Station and the Pacific Station. Why not put all our ships into one fleet, disregarding a few small ships that emergencies may call to such places at San Domingo? Why not concentrate our fleet now, and make it really a fleet, instead of waiting till war comes? If we wait till then, we shall not be able to bring into battle a coherent fleet, all we can do, if we succeed in uniting the two parts, will be to bring into battle two separate parts of a fleet, that will not be able to co-operate very well, from lack of practice. The only great disadvantage of the one fleet plan is that, at the outbreak of war, the enemy may be able to secure some important advantages at some place where our fleet is not. But our fleet

will get there in the end, and when it does get there, it will be really a fleet, and not a loose collection of squadrons; it will be able to deliver a blow of all its concentrated energy on any given point.

We hear it said that a fleet containing more than a certain number of ships cannot be handled. Why? Because we do not know how to handle it. How shall we learn? In the same way in which we learn to do everything else—by trying.

Suppose the Russians had had all their ships concentrated in one mighty fleet, that could be handled like an enormous engine. Suppose, even, that that fleet was far away from Asia when war began. It is true that the Japanese could have landed in Korea, but what would have happened when the Russian fleet finally got there? What would have been the condition of the Japanese army in Korea, forever cut off from communication with Japan?

Commander J. C. WILSON, U. S. Navy.—In response to the "Notice," requesting "Discussion on the Prize Essay," published in No. 109 of the PROCEEDINGS OF THE NAVAL INSTITUTE, I submit some views concerning the same; feeling that the subject treated is of such importance to the service that it is well that as many opinions as practicable be published, for the consideration of those who have, or may have, it in their power to do something to perfect the organization of "The Fleet and its Personnel of the Navy."

The essayist has placed the subject in such a shape as to make expressions of opinions on the merits or demerits of the changes proposed an easy matter. His suggestions are based on sound principles, and, if carried out will result in a vast improvement. The bringing and keeping of the same (or similar) class of vessels, together in squadrons, would be productive of the greatest good; and the idea of confining our battleships and battle cruisers, to the Atlantic and Pacific stations is, in my opinion, correct. These ships should as a rule cruise together in squadrons, and within reach of the "home base," both for perfection in drills, target practice, etc., and incidently for convenience of repairs, and supplies, and economy in the use of coal, which latter, as the navy increases will become a matter of more and more importance, though naturally it will never become a factor of sufficient importance to determine by itself the duty or station upon which a vessel should be employed. "Home bases" should, as far as practicable, fulfill the conditions mentioned in the essay.

These "bases" must be equally available in times of war, and peace, and they must be strongly protected; so that it would seem that the present navy yards must be used as "bases," and their berthing capacity for ships increased as much as practicable by the building out of docks, and making slips in which ships could enter and secure in the proper berths. If a sufficient number of separate berths could not be arranged in these slips, two vessels of the same class, could have the same berth, lying alongside of each other when necessary. In this way the navy yards at Boston, New York, League Island, and Norfolk could probably be made to accommodate all the ships on the Atlantic coast; leaving the other yards for

special purposes; while the yards at Mare Island, and Bremerton, could be made to accommodate the ships on the Pacific coast.

There is not room enough in the present navy yards for barracks large enough to accommodate recruits. The barracks at navy yards should be for the accommodation of those awaiting assignment to ships, or of a ship's company under such repairs as to make it impracticable for her crew to remain on board. Club houses, boat houses, gymnasiums and canteens should be established at each "base," and these could all be accommodated in one building; and where practicable a recreation ground should be added. The receiving ships should be discontinued as being unsuitable for present requirements.

I think it would be impracticable to build quarters for officers as suggested. The idea of having certain times of the year specified for vessels to be under repairs, is an excellent one; and each ship should be allowed to remain a month at the "base" each year, whether repairs required this length of time or not.

Squadrons should be kept in readiness on each coast to perform such detached duty in times of peace, as require immediate attention, leaving the "fleets," to carry out their prearranged programmes.

In this connection I think a number of gunboats should be built which could be utilized in station duty in the Caribbean Sea, China, and the Philippines, leaving all the other classes of vessels free to be mobilized with the fleet from time to time; and in the constant development of all matters pertaining to the duties of the ships and personnel in times of war.

The present so called protective cruisers are obsolete as war vessels, and should be replaced as rapidly as possible by armored cruisers, leaving the present protective cruisers for duty on the various stations. They would be expensive both in men and maintenance, but would save the expense of building so many gunboats. Scout vessels especially designed for speed and coal endurance should be constructed and attached to the "fleets."

Hospital, supply and repair vessels should be fitted out, or built as required, so that each "fleet" would be complete in all its details, and drill as nearly under the conditions of actual war as possible. It is not necessary that hospital and repair ships be kept fully manned at all times, but they should be commissioned at least once a year, and attached to the fleet to which they belong, for drill and practice, and especially to see that all details connected with their outfits are complete and in working condition.

I agree with the essayist that the recruits should be trained in barracks. Possibly in the cases of League Island, Mare Island, and Bremerton yards, such barracks could be built, in which case they are at a "home base," and well located. It would probably be necessary to purchase sites, and construct barracks at other points on the coast, and no other points equal the vicinity of Yorktown or Chesapeake Bay, for the establishment of a large model training station for recruits; and if necessary, another could be established on the Pacific coast. Each station should be in command of a captain with the following assistants:

1 Commander.

1 Lieutenant-Commander.
4 Lieutenants.

No other commissioned line officers should be attached to the station, all drilling and other divisional duties being performed by warrant officers or drill masters, with the rank of warrant officer, or C. P. O. It would be better to have a number of warranted and appointed drill masters, and assistants permanently attached to the station. There should be, of course, a sufficient number of staff officers and enlisted men to carry on the necessary duties.

A small handy steam vessel, with suitable main and secondary batteries, should be attached to each station for the training of seamen and firemen. So called training-ships now in commission should be assigned to other duties or put out of commission, utilizing such as are suitable for the training stations.

I agree with the essayist, that the apprentice system should be merged into the general training system, and think that Rear Admiral Wise's suggestion should be adopted as to the title by which recruits should be known, viz., apprentice-seamen. Apprentice-firemen should also be added.

There are now approximately 85 line officers, 30 staff officers, 60 warrant officers, and 1000 enlisted men attached to the training service.

Five training stations for recruits organized as suggested would require about 30 line officers, 15 staff officers, 20 warrant officers (besides drill masters) and 300 enlisted men, leaving about 55 line officers, 15 staff officers, 40 warrant officers, and 700 blue jackets, for general service; enough officers to man 4 battleships, and men enough for at least one battleship.

The present training system is too expensive in every way, and not productive of the best result.

At a properly equipped training station, men could be trained ready for sea service in six months (the undesirable ones being weeded out in the meantime) then with six months' training on a cruiser they should be ready to be transferred to a battleship as ordinary seamen, or firemen 2d class, with three years to serve. Those who show special aptitude, for special branches should be, when practicable, sent to schools of special instruction, six months before the expiration of their terms of enlistment, but no enlisted man should be given a permanent appointment as petty officer during his first enlistment. His discharge from first enlistment should indicate what rate he was best fitted to have, and if possible he should be given an acting appointment in that rate upon re-enlistment; unless he has served his probationary time as petty officer, when he should be given a permanent appointment upon his re-enlistment. This, besides furnishing a supply of petty officers, would be an incentive for men to re-enlist.

The suggestion that more employment at naval stations should be assigned to enlisted men of the service, is an excellent one. If enlisted men could feel that after the expiration, say of their third enlistment, they would have a fair proportion of their duty during the remainder of their lives in the service, what now is a great objection in the minds of most

men to continue in the service, viz., impossibility of enjoying domestic life and the breaking up of some associations, would be removed.

Lieutenant-Commander H. S. KNAPP, U. S. Navy.—There is so much in the essayist's admirable paper that calls for hearty assent that less hesitation is felt in responding to his expressed desire for a full discussion by calling attention to a few points in which his conclusions seem open to criticism.

The proposed distribution of the sea-going battle fleet is not believed to be sound, much as the principles of its organization are to be desired. But until our country has the forty battleships for which the essayist argues, or something near that number, the presence of any battleships in the Pacific will be a source of weakness. For the present, at all events, our battleships should *all* be in the Atlantic. It will always be imperative to have the greater proportion of them there, and to keep a part of the battleship fleet in the Pacific violates the principle of concentration. Of the great naval powers, leaving aside Russia and Japan, England had in the Pacific on February 1 of this year five battleships of the classes rated by Jane as I or II, 13% of her complete battleships of those ratings; France and Germany had none of those ratings in the Pacific; the United States had three, or 27%. By the recent return of the Kentucky this ratio has been reduced to 18%. The essayist's proposed distribution places 33% of the battleships in the Pacific. Though England's fleet is not concentrated in home waters, her Mediterranean squadron is so strong that it could fight its way home if necessary, and the five ships in the Far East can be spared from thirty-eight without a violation of the principle of concentration. Germany's fleet is actually concentrated. In France protests have recently appeared in the press against the dispersion involved in keeping up the Mediterranean and Atlantic divisions of the fleet, though both are in home waters. In our own case if war were to come upon us now we could justly be accused of failure to profit by the lesson of the Oregon's long trip on the eve of the Spanish war. Any serious war in which we may become engaged will be against a European nation or Japan. Our two battleships on the China station could do nothing against Japan's concentrated fleet. If we become engaged in war with a nation of Europe, we shall need our whole fleet in the Atlantic until it is much stronger than now, built or building, and to effect concentration in the face of a European nation holding an interior line will be exceedingly difficult, if not impossible. The completion of the Isthmian canal will be a military advantage of the highest value in this connection. But until it is finished and until we have such a sufficient number of battleships that the main fleet is large enough not to need the Pacific squadron, and the latter can stand alone against any probable adversary, concentration in the Atlantic should be our policy.

The fleet organization should include ammunition ships. It is startling to compute how quickly a ship's ammunition can be expended, using actual firing rates as data; and it is equally startling to hear of some expedients that have been resorted to in piping times of peace to meet the ordinary demands of service. Our ammunition is a highly specialized

product obtainable only in the United States. Foreign coal may be obtained in spite of its being contraband; but foreign ammunition will not fit our guns.

Four scouts for the unit battle fleet proposed is a very insufficient number, even adding the four armored cruisers for scouting duties. They could not screen the main body on the high sea, nor would they be in sufficient numbers to ensure the service of security and information about a fleet at a temporary base near the enemy, counting the necessary reliefs for repairs and to coal.

The building of protected cruisers for any war duty except scouting is believed by a large body of expert opinion to be a useless expenditure. The paper by Naval Constructor Taylor in No. 109 of the PROCEEDINGS shows the trend of present opinion in a striking way. It is difficult to point out any specific things that a large protected cruiser can do in war that an armored cruiser cannot do, on the one hand, or a scout on the other. And what to do in war with small protected cruisers of moderate speed, like our Denver class, unless it be to maintain a commercial blockade, is a question even more difficult to answer satisfactorily.

A mere title is a small matter for serious discussion unless it conveys a wrong impression. Such a wrong impression is conveyed by the term "battle-cruiser," which virtually means that an armored cruiser may take a place with battleships in the line of battle. The essayist's argument for the use of the term shows that he had that very thing more or less in mind, an idea that is believed by a large body of officers to be fallacious and dangerous. The Washington and Tennessee are quoted as excellent examples of the type of ship so designated, and it may be well to examine their armor and armament in this connection. Their belt and battery armor is 5 inches thick, and they carry 10-in. and 6-in. guns. Comparing them with the Idaho class, in which the belt armor has been reduced to 9 inches, 2 inches less than that of any of our other classes of battleships, and whose guns are of 12-in., 8-in. and 7-in. caliber, a Washington has to be within about 5,000 yards before her 10-in. guns are effective against the Idaho's 9-inch armor, at which range the Idaho's 12-in. and 8-in. guns are effective against all of the Washington's armor excepting the turrets. The proportion is 2 broadside guns to 1 at the range noted, which is the limiting position outside of which there is no sense in the Washington's being at all if she intends to fight, because outside of it she could inflict no vital damage. If the action be within 4,000 yards, the proportion is greater, being 13 guns to 4, the Idaho's 7-in. guns now being effective against the Washington's 5-inch armor, while the latter's 6-in. guns can do little more than scratch the Idaho's paint. In the face of such odds it seems absurd to think of pitting armored cruisers against battleships. Against a Maine, a Georgia or a Connecticut the case is worse for the Washington; while if the Maryland be substituted for the Washington the extra thickness of armor is offset by the smaller caliber of the Maryland's heaviest guns. Some ships rated as armored cruisers might have a fair chance against some others rated as battleships; but it seems a grievous error to have the idea gain a foothold that armored cruisers are fit for the battle line, and the new term proposed certainly lends itself to that idea.

PROFESSIONAL NOTES.

Prepared by Professsor PHILIP R. ALGER, U. S. Navy.

SHIPS OF WAR, BUDGETS, AND PERSONNEL.

AUSTRIA.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Erherzog Karl.....	10,600	Trieste.	Launched Oct. 4, 1903.
Erherzog Friedrich .	10,600	"	Launched April 30, 1904.
C.....	10,600	"	Projected.
Babenburg.....	8,340	Pola.	Under trial.
Armored Cruiser.			
Saint Georg.....	7,400	Pola.	Launched Dec. 8, 1903.
River Monitors.			
Save.....	450	Neupesth.	Launched March 25, 1904.
Theiss.....	450	"	" " " "

The Austrian delegation on June 1 adopted the budget of the Ministry of Marine, as well as the extraordinary credits amounting to 75,000,000 kronen required for the navy. Admiral Spaun said that the credits asked for would be employed in the rapid construction of the fleet. Rapidity of construction was necessary because the battleships, as well as the torpedo vessels, were no longer up to the standard of a modern fleet. "In a year and a half," continued Admiral Spaun, "we shall have the same number of battleships as we had in 1870, but without the new credits we should have had to wait eleven years for the reconstruction of the fleet. It is also necessary to protect the harbor and fortress of Pola, for the Russo-Japanese war has proved the dangers to which a daring attack of the enemy can expose vessels anchored in an incompletely protected port. As regards submarines, the government intends to build one for the present, and only to continue their construction if the tests prove satisfactory.—*United Service Gazette.*

On April 30 the Austrian battleship Erzherzog Friedrich was launched at Trieste. Her length is 387 feet; beam, 71.23 feet; draft, 24.54 feet; displacement, 10,600 tons; engines, 14,000 horsepower; speed, 19.25 knots. Her armor-belt will extend 4 feet 9 inches above and 3 feet 11.24 inches below the water-line. The whole of her armor will be of Witkowitz nickel steel and will weight 2922 tons. Her auxiliary engines will number 87, with 140 steam cylinders. She will carry four 9.45-inch, twelve 7.48-inch, fourteen 2.75-inch, and ten 1.45-inch guns, four mitrailleuses, and two submerged torpedo-tubes of 17.71-inch caliber. Her 7.48-inch guns will each fire four rounds a minute.—*U. S. Gazette.*

FRANCE.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
République	14,865	Brest.	Launched Sept., 1902.
Démocratie.....	14,865	"	Launched May 2, 1904.
Patrie	14,865	La Seyne.	Launched Dec. 17, 1903.
Justice.....	14,865	"	Ordered.
Vérité.....	14,865	Bordeaux.	Building.
Liberté.....	14,865	St. Nazaire.	"

VESSELS BUILDING—*Continued.*

Name.	Displacement.	Where Building.	Remarks.
Armored Cruisers.			
Ernest Rénan	13,562	Brest.	Building.
Jules Michelet	13,562	Lorient.	"
Jules Ferry	12,550	Cherbourg.	Launched Aug. 23, 1903.
Victor Hugo	12,550	Lorient.	Launched March 30, 1904.
Léon Gambetta	12,550	Brest.	Under trial.
Amiral Aube	10,014	St. Nazaire.	" "
Sully	10,014	La Seyne.	" "
Condé	10,014	Lorient.	" "
Gueydan	9,516	....	" "
Dupetit Thouars	9,516	Toulon.	Launched July, 1901.
C 16	13,562	....	Authorized.
C 17	13,562	....	"

The French armored cruiser Victor Hugo was launched at Lorient on March 30. The following are her characteristics: Lengh, 491 feet; beam, 70 feet 3 inches; draft, 25 feet 3 inches; displacement, 12,600 tons; engines, 27,500 horsepower, supplied by twenty-eight Belleville boilers; speed, 22 knots. When launched she was already fitted with her Belleville boilers. She had been on the stocks for thirteen months, some delay having been caused by the transfer to Lorient of the material from Toulon, where it was intended originally that she should be built. Her armor belt will be 6.7 inches thick amidships, tapering to 3.9 inches fore and aft. It will extend to 7.54 feet above the water-line, and from there the protection will be continued to the casemates of the 6.5-inch guns by 5-inch armor. The two armor decks will start respectively from the top and the bottom of the armor belt, the space between them being divided into numerous water-tight compartments. The cruiser will carry four 7.6-inch guns, two in each turret fore and aft, and sixteen 6.5-inch guns, twelve in six turrets and four in casemates; also five torpedo tubes, of which two will be submerged. She will have four funnels and two masts, but only one with a fighting top.—*A. & N. Gazette.*

No sooner had the Victor Hugo been launched at Lorient than the slip upon which she was built was appropriated to the construction of the Jules Michelet, the fourth cruiser of the type ordered by the decree of April 5, 1902. The execution of this programme has been somewhat delayed, but it is not anticipated that its completion will be very greatly affected thereby, and the vessel now laid down is expected to be ready for service by January, 1907. As compared with other cruisers of a similar type, her displacement has been increased by 20 tons, and her horsepower is to be greater by 1500. Ther are rumors also of important changes in armament, and it is said that in place of four guns of 7.8 inches and sixteen of 6.6 inches, she is to be armed with two of 9.6 inches and twelve of 6.6 inches.—*U. S. Gazette.*

As projected some months ago, the armament of the French Liberté, Démocratie, Justice, and Verité has now been definitely fixed at four 12-inch, ten 7.6-inch, and eight 4-inch guns. The 7.6-inch is a remarkable piece, with a shot of only some 155 lb. in weight, against 200 lb. of our 7.5-inch; but its penetration is about the same as that of the 9.2-inch mounted in our armored cruisers and Cressy class, only 2 inches less than those in the King Edward. So far as penetration goes the Liberté's will almost be King Edward's, with the secondary battery composed of 9.2-inch's. There is food for thought here. Secondary guns that can pierce the King Edward's belt at 3000 yards are serious factors, even though the hole they could make is trifling.—*Engineer.*

Some interesting details about the new French torpedo-boats have been made public. The class is numbered 278-292, and the vessels are 121.4 feet in length. They displace 90.6 tons, and, with engines designed to develop 1900 horsepower, are expected to make 26 knots speed. No. 279, which is already complete, made on her trials 26.55 knots. Two others of different design have just been launched—No. 293 at the Normand Yard, Havre; and No. 294 at Bordeaux. No. 293 is 129 feet in length, displaces 97 tons, and is fitted with Parsons's turbine engines. Three turbines will be used when she is going at full speed (24 knots); one will be used for cruising speeds, and one for going astern. Her boilers will be Normand water-tube. No. 294 will be 126 feet long, and fitted with turbines of Bréguet design. Her speed will also be 24 knots.—*Page's Magazine.*

The French ships and vessels to be continued or begun during the year 1905 will be inferior in number by thirty-one to those in progress in the present year. This difference is in two armored cruisers, three destroyers, one torpedo-boat, and twenty-five submarines, and results chiefly from the completion of twenty submarines ordered in 1901. The *Moniteur de la Flotte* says that all the vessels laid down previous to the voting of the programme of 1900 will be completed before the end of the present year, though a few changes may remain upon the next estimates. The vessels to be begun will be one armored cruiser, four destroyers, and eight submarines in the dockyards, and twenty torpedo-boats in private yards. The vessels carried forward will be five battleships, four armored cruisers, eight destroyers, fifty-five torpedo-boats and twenty-three submarines. In addition to these, one battleship, one armored cruiser, and twenty-one torpedo-boats will be completed. The armored cruiser to be laid down is known as C 17, and will probably be of the same type as C 16, which has not yet been laid down, and is to be analogous to the modified Ernest Renan. The four destroyers will be of the Stylet type, and are known as M 40 to M 43. They are to be 28-knot boats, with a displacement of 336 tons. For the new torpedo-boats, fresh plans are being prepared.—*A. & N. Gazette.*

It was intended in 1903 to lay down eighteen submarines or submersibles, but fresh plans were made, and as a result six submarines of a new type, designed by M. Maugas, and of a much greater tonnage, were begun last October. They bear the names of Emereaud, Opale, Rubis, Saphir, Topaze and Turquoise. The first three are in hand at Cherbourg and the others at Toulon. The *Moniteur* says their characteristics have never been officially published, but that they are as follows: Displacement, 422 tons; length, 144 feet; beam, 13 feet; 600 horsepower; electric motors, accumulators, and explosive motors; two screws; speed, twelve knots; six launching tubes. Of the sixteen submarines or submersibles to be begun this year, four will be put in hand at Cherbourg and twelve at Toulon, while next year three will be begun at Toulon and two at Rochefort. The plans are not yet ready.—*A. & N. Gazette.*

The *Moniteur de la Flotte* and the *Yacht* give some particulars of the recent accident to the armored cruiser Léon Gambetta. She was engaged in running preliminary trials and the captain took a course with the view of passing to the south of the reef of the Black Rocks outside Brest. At the time snow squalls were passing over, and nothing was visible. The compass of the cruiser had been adjusted in the preceding week, but the bad weather had interrupted the operation, and it appears that a wrong indication was given to the extent of about five degrees. It was this which caused the accident. The speed was sixteen knots and the cruiser ran upon a point of rock, striking upon the starboard side near the stem,

afterwards touching the rock further aft, and her bilge keel was carried away for the greater part of its length. Water entered in two places, invading the double bottom, while the wings of the central and starboard screws were damaged. The *Moniteur* says there was no panic on board, and that the ship proceeded easily into Brest. There is only one dock, apparently, into which she can be taken, and, inasmuch as the Marseillaise is there at the present time, she will have to wait awhile. Meanwhile the port is busy making the wings of the screws to replace those which are broken. It is uncertain how long will be required to complete them.—*A. & N. Gazette.*

Some particulars have come to hand of the French torpedo-boat now being fitted with Parsons steam turbines with the view of testing these in competition not only with steam engines, but also with the turbines on the principle of Professor Rateau, of Paris. This latter make of turbine is not so well known in this country as in France, where fifty of 25,000 horsepower are in use or in process of construction, and of these 6200 indicated horsepower are for ship propulsion. The two boats fitted with Parsons and Rateau turbines are practically alike. The dimensions of the vessels are: Length, 129 feet 7 inches; beam, 13 feet 7 inches; and, with a draft of 8 feet 2 inches, the displacement is 94 tons. Normand boilers are fitted, and on each of three shafts there is one go-ahead turbine dimensioned to admit of compound expansion of steam, and to give a maximum of 1800 indicated horsepower. The fourth turbine, mounted on the central shaft, is for reverse motion. Each shaft will have only one propeller. This decision has followed upon experience in this country, because French engineers started with the idea of fitting three on each shaft, as was the case with the first Rateau turbine boat. The general opinion now favors single screw, but the Germans mean to try various arrangements and various designs of blades. The French boat is to have a radius of action of 20 miles at the full speed of 25 knots, and of 1800 miles at 10 knots. The armament consists of one deck tube for launching torpedoes and two 1-pounder guns. The vessel was ordered from Normand in October, 1902, but will not be ready for her full-power trials for a few days. Her cost is £22,425.—*U. S. Gazette.*

The first-class armored cruiser Jeanne d'Arc, which has been now for some months in the dockyard hands at Brest, has recommenced her trials, but they have not been satisfactory. Among other modifications made while the ship was in dock, was the reducing of the size of her bilge keels; but she is still unable to do more than 22 knots, in place of the 23 for which she was designed, and her screws are again to be changed; she has no difficulty in maintaining a speed of 19 knots, and can pass rapidly from 10 to 15 knots, and from 15 knots to 20; and as she has a large radius of action, is well protected, and well armed, in spite of her failure to realize 23 knots, she is still a formidable and useful cruiser.

The new first-class cruiser Léon Gambetta, which ran on a rock while on her trials off Brest on May 1, was taken into dock on May 21, and orders have been received to press on with her repairs. The delay in docking her is due to the fact that there is only one dock at Brest apparently capable of taking in a ship of her size, and as this was occupied by the Jeanne d'Arc, she had to wait until that ship could be moved. At the inquiry since held, the pilot in charge stated he did not think she struck any wreckage, but that owing to the compasses not being properly adjusted, and to a heavy snow squall at the time of the accident obscuring the horizon and leading marks, she got off her course and proably struck a pinnacle rock. Two tugs and three torpedo-boats have since been searching for the supposed rock, but it has not yet been located.—*U. S. Institution.*

GERMANY.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Braunschweig	13,200	Kiel.	Launched; complete in 1904.
Hesse	13,200	Dantzic.	" May 26, 1903.
Prussen	13,200	Stettin.	" Oct. 31, 1903.
Rossen	13,200	Kiel.	Launched Sept. 18, 1903.
Lothringin	13,200	Dantzic.	Launched May 27, 1904.
N	13,200	Gaarden.	Building.
Armored Cruisers.			
Prinz Adalbert	9,050	Kiel.	Under trial.
Roon	9,050	Kiel.	Launched June 27, 1903.
York	9,050	Hamburg.	Launched May 14, 1904.
F	9,050	Kiel.	Building.
Protected Cruisers.			
Cadine	2,715	Kiel.	Under trial.
Hamburg	3,000	Stettin.	" "
Bremen	3,000	Bremen.	Launched July 9, 1903.
Berlin	3,000	"	Launched Sept. 22, 1903.
Munich	3,000	"	Launched April 30, 1904.
Lubeck	3,000	Stettin.	" March 26, 1904.

THE ESTIMATES FOR 1904.—The estimates for 1904 amount to 225,953,990 marks (£11,297,699 10s.), as against 209,551,124 marks (£10,477,556 4s.) voted for 1903, showing an increase of 16,402,866 marks (£820,143 6s.). The following are the principal items:

ORDINARY PERMANENT ESTIMATES.

	Proposed 1904.			Voted 1903.	
	Marks.	£	s.	£	s.
Imperial Ministry of Marine and Naval Cabinet	1,599,640 =	(79,982	0)	78,519	0
Naval Headquarters Staff	204,280	(10,214	0)	9,522	5
Observatories, etc.	349,514	(17,475	14)	16,970	5
Station Accounts Department	434,520	(21,726	0)	20,632	5
Legal Department	124,420	(6,221	0)	5,246	0
Chaplains' Department and Garrison Schools	111,215	(5,560	0)	5,235	12
Pay of Officers and Men	22,329,517	(1,116,475	17)	1,045,183	9
Maintenance of Fleet in commission	25,971,797	(1,298,589	0)	1,197,581	1
Allowances for Officers and Men	1,739,379	(86,968	0)	74,973	14
Clothing	377,575	(18,878	15)	17,885	11
Barrack and Garrison Administration, etc.	1,332,969	(66,648	9)	60,243	8
Lodging Allowance	3,437,998	(171,899	18)	160,653	18
Medical Department	1,647,361	(82,368	1)	76,289	17
Traveling, Transport and Freight Charges	3,375,000	(168,750	0)	143,540	15
Training Establishments	364,278	(18,213	18)	17,298	11
Maintenance of the Fleet and Dockyards	25,272,315	(1,263,615	15)	1,203,392	14
Ordnance, Arms and Fortification	8,463,482	(423,174	2)	405,354	14
Accountant-General's Department	700,034	(35,001	14)	32,817	11
Pilotage and Surveying	647,219	(32,360	19)	29,437	8
Miscellaneous Expenses	1,255,084	(62,754	4)	59,098	14
Administration of Kiau-Chau Protectorate	90,023	(4,501	3)	3,591	2
Total	99,827,620	(4,991,381	0)	4,663,462	14

SPECIAL ORDINARY ESTIMATES.

Shipbuilding Program for 1904.

For the construction of the following ships:

	Marks.	£	s.
The first-class battleship Braunschweig (H), 4th and final vote	2,350,000	= (117,500	0)
The first-class battleship Elsass (J), 4th and final vote	2,350,000	(117,500	0)
The first-class battleship Preussen (K), 3d vote	4,650,000	(237,500	0)
The first-class battleship Hessen (L), 3d vote	4,650,000	(237,500	0)
The first-class battleship M, 2d vote	6,050,000	(302,500	0)
The first-class battleship N, 2d vote	6,050,000	(302,500	0)
The first-class battleship O, 1st vote	2,600,000	(130,000	0)
The first-class battleship P, 1st vote	2,600,000	(130,000	0)
The first-class armored cruiser Roon (Ersatz Kaiser), 3d and final vote	5,500,000	(275,000	0)
The first-class armored cruiser Ersatz Deutschland, 2d vote	5,030,000	(251,500	0)
The first-class armored cruiser C, 1st vote	3,200,000	(160,000	0)
The third-class cruiser Hamburg (K), 3d and final vote	1,090,000	(54,500	0)
The third-class cruiser Bremen (L), 3d and final vote	1,090,000	(54,500	0)
The third-class cruiser Berlin (Ersatz Zieten), 3d and final vote	1,090,000	(54,500	0)
The third-class cruiser M, 2d vote	2,435,000	(121,750	0)
The third-class cruiser Ersatz Merkur, 2d vote	2,435,000	(121,750	0)
The third-class cruiser N, 1st vote	1,225,000	(61,250	0)
The third-class cruiser Ersatz Alexandrine, 1st vote	1,225,000	(61,250	0)
The third-class cruiser Meteor, 1st vote	1,225,000	(61,250	0)
For the reconstruction of the ships of the Brandenburg class, 3d and final vote	550,000	(27,500	0)
For the fitting of cooling and ventilating apparatus for ships' magazines, 3d and final vote	2,720,000	(136,000	0)
For the thorough overhaul and repair of the first-class cruiser Kaiserin Augusta, 2d and final vote	1,500,000	(75,000	0)
For the thorough overhaul and repair of the second-class cruiser Irene, 2d and final vote	1,200,000	(60,000	0)
For the construction of a sea-going dredger, 2d and final vote	700,000	(35,000	0)
For the construction of gunboat C, 1st vote	800,000	(40,000	0)
For the construction of a tender for the gun-trial and school-ship	450,000	(22,500	0)
For the construction of a surveying vessel	750,000	(37,500	0)
For the construction of a division of torpedo-boats, 2d and final vote	2,440,000	(122,000	0)
For the construction of a division of torpedo-boats, 1st vote	3,100,000	(155,000	0)
Total	71,055,000	(3,552,750	0)
For the gun and torpedo armaments of new ships	29,316,000	(1,465,800	0)
Miscellaneous expenditure: dock-yards, etc	7,185,370	(359,268	10)
	107,556,370	(5,377,818	10)
From which has to be deducted, credited in the Extraordinary Estimates	32,115,0000	(1,605,750	0)
Leaving total	75,441,370	(3,772,068	10)

Summary.

	1904. Marks.	£	s.	1903. £	s.	Increase, 1904. £	s.
Ordinary Permanent Estimates	99,827,620	(4,991,381	0)	4,663,462	14	(+327,918	6)
Shipbuilding, Armament, etc.	75,441,370	(3,772,068	10)	3,455,343	10	(+316,725	0)
Extraordinary Expenditure	50,685,000	(2,534,250	0)	2,358,750	0	(+175,500	0)
Total	225,953,990	(11,297,699	10)	10,477,556	4	(+820,143	6)

The Personnel of the Fleet.—The following are the numbers of the officers of different ranks on the active list of the fleet: 5 admirals, 7 vice-admirals, 17 rear-admirals, 63 captains, 137 frigate and corvette captains, 277 captain-lieutenants, 772 lieutenants, 368 midshipmen and 150 cadets. There are, further, 1 retired rear-admiral, 12 retired captains, 20 retired frigate and corvette captains and 1 retired lieutenant employed on special duties, while 37 captain-lieutenants and 62 lieutenants are employed in ordnance and torpedo duties in the various dock-yards and coast stations. The total number of commissioned officers of the military branch actively employed is thus 1278, showing an increase of 140 over last year, viz.: 1 vice-admiral, 1 rear-admiral, 3 captains, 14 frigate and corvette captains, 36 captain-lieutenants and 85 lieutenants.

The marine battalions have as their staff: 1 inspector of marine infantry, 2 battalion commanders, 15 captains, 10 first lieutenants and 22 lieutenants, showing an increase of 2 captains and 4 lieutenants over last year. The engineering department consists of: 6 chief engineers, 35 staff engineers, 73 engineers first class and 109 engineers, being an increase of 1 chief engineer, 2 staff engineers, 5 engineers first class and 8 engineers.

The medical department consists of: 1 medical director-general (with the rank of rear-admiral), 3 inspectors-general, 37 fleet surgeons, 72 staff surgeons, 42 surgeons and 42 assistant surgeons, showing an increase of 3 fleet surgeons, 4 staff surgeons, 2 surgeons and 2 assistant surgeons.

In the accounting department are: 22 staff paymasters, 142 senior paymasters and paymasters, showing an increase of 6 staff paymasters and 13 senior paymasters and paymasters.

The seamen divisions number: 88 chief warrant officers, 165 warrant officers and 13,923 petty officers and men, with 1100 boys, a total of 15,023, showing an increase of 15 chief warrant officers, 15 warrant officers and 770 petty officers and men, the number of boys remaining the same.

The dock-yard divisions number: 276 chief warrant officers, 553 warrant officers and 9160 petty officers and men, of whom 726 chief and warrant officers, with 7163 petty officers and men form the engine-room *personnel* of the fleet, which shows an increase of 59 chief warrant officers and 852 petty officers and men over last year, with a total increase in the divisions of 68 chief and warrant officers and 971 petty officers and men.

The torpedo divisions number: 79 chief warrant officers, 160 warrant officers and 4024 petty officers and men, of whom 47 chief and warrant officers and 1889 petty officers and men are of the seamen class, while 194 chief and warrant officers and 2135 petty officers and men are of the engineering branch; there is an increase in the divisions of 3 chief warrant and 6 warrant officers, with 171 petty officers and men of the engineering branch, and of 170 petty officers and men of the seamen branch, or a total increase in both branches of 9 chief and warrant officers and 291 men.

The seamen-artillery division numbers: 11 chief warrant officers, 18 warrant officers and 2422 petty officers and men, showing an increase of 64 petty officers and men.

The marine infantry numbers: 191 non-commissioned officers and 1038 men—a similar strength to last year.

The sick-bay staff consists of: 310 petty officers and men of various grades, an increase of 30 over the previous year; and there are 227 ships' stewards and assistants, an increase of 13.

The total strength of the active *personnel* of the navy stands at 38,025, viz.: 1901 officers, exclusive of midshipmen and cadets, and 36,124 warrant officers, petty officers, men and boys, being an increase of 179 officers and 2161 men over last year.

The Matériel of the Fleet.—The matériel of the fleet, including ships under construction, is made up as follows: Battleships, 35, to be increased to 38, in accordance with the navy act of 1900. Of these there are 14 first-class battleships completed, 4 in different stages approaching completion, two to be launched this year (1 of these was launched on May 28), and 2 others to be laid down during the year; 5 third-class battleships and 8 fourth-class; these last are rated as coast-defense ships and will, with the third-class ships, be in due course replaced by first-class vessels.

Large cruisers, 13, to be increased to 14. Of these there are 4 first-class armored cruisers completed, 2 under construction and 1 to be laid down. The remaining 6 are protected vessels.

Small cruisers, 35, to be increased to 38. Of these there are 27 completed, 3 approaching completion, 2 under construction and 3 to be laid down.

There are 7 first-class gunboats and 4 river gunboats; 3 of the latter are completed and 1 completing.

The torpedo flotilla consists of 47 of what are practically destroyers, all, with the exception of three having displacements of from 320 to 380 tons, with a speed of from 25 to 30 knots; there are, in addition, 47 smaller sea-going torpedo-boats and some 38 second-class boats for harbor and coast defense. Six destroyers are under construction and six more are to be laid down this year.

The training squadron for cadets and boys of: 6 sea-going cadet and boys' school frigates; and there are 7 gunnery training ships, 1 torpedo school ship and 2 submarine mine training ships.

The special service ships are: 2 imperial yachts, 3 surveying ships, 1 stationaire at Constantinople and a torpedo depot ship with her tender.—*Etat für die Verwaltung der Kaiserlichen Marine auf das Rechnungsjahr* 1904. (Translation from *United Service Institution.*)

The German cruiser Lubeck was launched at the Vulcan Works at Stettin on March 26th. She is of 3000 tons, and is to be fitted with turbine engines. Her estimated speed is twenty-two knots.—*U. S. Gazette.*

The Berlin correspondent of the *Times* states it is announced that the General Staff of the Germany navy will be supplemented by a Great General Staff of the navy. The chief of the General Staff of the navy, Vice-Admiral Buchsel, will be entrusted with similar duties in connection with the new advisory board. The Great General Staff of the German navy will be composed of seven naval captains, two frigate-captains, 12 corvette-captains, and 21 commanders, together with officers serving in the navy as chief of the staff or engaged upon Admiralty duties. The Great General Staff of the navy will therefore consist of 45 members, of whom 26 will be stationed in Berlin.—*U. S. Gazette.*

GREAT BRITAIN.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Africa	16,350	Chatham.	Building.
Britannia	16,350	Portsmouth.	"
Hibernia	16,350	Devonport.	"
Hindostan	16,350	Clydebank.	Launched Dec. 18, 1903.
New Zealand	16,350	Portsmouth.	Launched Feb. 4, 1904.
Commonwealth	16,350	Glasgow.	Launched May 13, 1903.
Dominion	16,350	London.	Launched Aug. 25, 1903.
King Edward VII	16,350	Devonport.	Launched July 23, 1903.
Queen	16,000	"	Under trial.
Prince of Wales	15,000	Chatham.	" "
Armored Cruisers.			
Duke of Edinburgh	13,500	Pembroke.	Launched June 14, 1904.
Black Prince	13,500	Blackwall.	Building.
Warrior	13,500	Pembroke.	"
Cochrane	13,500	Glasgow.	"
Natal	13,500	Barrow.	"
Achilles	13,500	Newcastle.	"
Hampshire	10,700	Elswick.	Launched Sept. 24, 1903.
Devonshire	10,700	Chatham.	Launched April 30, 1904.
Roxburgh	10,700	Glasgow.	Launched Jan. 19, 1904.
Antrim	10,700	Clydebank.	Launched Oct. 8, 1903.
Argyll	10,700	Greenock.	Launched March 3, 1904.
Carnarvon	10,700	Glasgow.	Launched Oct. 7, 1903.
Cornwall	9,800	Pembroke.	Under trial.
Suffolk	9,800	Portsmouth.	"
Lancaster	9,800	Elswick.	"
Protected Cruisers.			
Encounter	5,880	Devonport.	Launched June, 1903.
Topaz	3,000	Birkenhead (Laird).	Under trial.
Amethyst	3,000	Elswick (Armstrong).	Launched Nov. 5, 1903.
Diamond	3,000	Birkenhead (Laird).	Launched Jan. 6, 1904.
Sapphire	3,000	Yarrow (Palmer).	" March 17, 1904.
Gunboats.			
Cadmus	1,096	Sheerness.	Launched April 29, 1903.
Clio	1,096	"	Under trial.
Scouts.			
Adventure	2,750	Elswick.	Building.
Forward	2,545	Fairfield.	"
Pathfinder	2,610	Birkenhead.	"
Sentinel	2,900	Vickers.	Launched April 19, 1904.
Skirmisher	2,900	"	Building.
Foresight	2,545	Fairfield.	"
Attentive	2,750	Elswick.	"
Patrol	2,610	Birkenhead.	"

The British naval programme for 1904 is an expensive and elaborate one, the estimates for the ensuing year aggregating $184,445,000. This sum represents an increase of $12,160,000 upon the estimates for 1903, and is the largest sum ever voted by the British government for naval purposes for one year.

The sum to be expended upon the construction of new vessels is $58,370,880, which is also an increase of $7,588,730 upon that for 1903. Of this sum, however, $5,000,000 will be devoted to the completion of the purchase for $9,375,000 of the vessels Constitution and Libertad which were built for the Chilian government and which were recently secured by the British Admiralty.

One result of their purchase has been the modification of the shipbuilding programme so far as concerns the construction of battleships. Only two battleships, instead of three, are authorized for the ensuing year. The composition of the new programme is as follows: First-class battleships, 2; armored cruisers, 4; destroyers, 14; submarines, 10; making a total of 30 vessels to be added to the fleet.

During the past twelve months, from April 1, 1903, to March 31 of this year, the British navy has been augmented by 40 ships composed as follows: Battleships, 6; armored cruisers, 9; second-class cruisers, 1; sloops, 2; submarines, 3; destroyers, 11; torpedo-boats, 8.

By April 1 of this year the following ships will be in course of construction: Battleships, 8; armored cruisers, 13; second-class cruisers, 1; third-clas cruisers, 4; scouts, 8; destroyers, 23; submarines, 11; river gunboats, 6. Total, 69 vessels.

During the twelve months from April 1, 1904, to March 31, 1905, which is the official year of the British government, 32 of these vessels will have been completed and passed into the navy. This addition will be composed of: Battleships, 3; armored cruisers, 5; second-class cruisers, 1; third-class cruisers, 4; destroyers, 8; submarines, 10; river gunboats, 1.

In the two battleships authorized in the current programme, the Admiralty propose to introduce a new class of vessel to be known as the Lord Nelson class. The heaviest battleships at present in the British navy are those known as the King Edward VII class, of 16,350 tons, and approximate the Connecticut class at present being built for our own navy. Mr. Philip Watts, the British naval designer and director, however, has a firm confidence in the heavy battleships, and these new ships will surpass the King Edward VII class. Although the tonnage, and in fact any particulars concerning this new type of battleship are being withheld from publication, I am in a position to state that they will approach the 18,000-ton vessels which were described some little while ago in the *Scientific American*. Their armament will be particularly formidable, especially so far as concerns the secondary class. They will each carry eight 9.2-inch guns in addition to the four 12-inch weapons, with ten 6-inch quick-firers in the central battery. The protective armor will resemble that of the King Edward VII class, only it will be commensurate with the larger dimensions of the new ships. Each vessel will cost $8,000,000.

During the past year the construction of the eight vessels constituting the authorized number for the King Edward VII class, has been hurried forward. This course has been decided upon so that the Admiralty may have a homogeneous squadron composed of boats of the same design, speed, etc., since experience has shown that four sister ships form a unit possessed of great tactical and administrative convenience. The vessels in this squadron will be divided into two divisions of four vessels each. One very prominent feature of the British naval department is the celerity with which the work of construction is undertaken in both the government and private dockyards. During the past twelve months the government dockyards have carried out their work so efficiently and expeditiously that the construction programme of last year had to be accelerated in order to keep the yards sufficiently provided with work. The armored cruisers which are to be laid down this year will be of the Duke of Edinburgh type, armed with six 9.2-inch guns, and ten 6-inch guns, with a speed of 22¼ knots.

Special attention is being devoted to the construction and equipment of the fleet with efficient submarines. The naval department is convinced that this type of vessel has a useful sphere of action. Prolonged experiments have taken place during the past twelve months with the submarines already in commission. The ten submarines projected in the current programme are to be built upon the designs formulated as the result of the experiments upon the designs prepared by Messrs. Vickers, Sons & Maxim, Limited, the constructors of the present submarines.

The construction of the destroyers is being delayed somewhat, as the Admiralty desire to prove the efficiency of the steam-turbine-propelled ship more completely, before they commit themselves definitely to any system of propulsion for these craft. The various tests with the Velox and Eden, both of which are fitted with Parsons turbines, have not yet been carried out. Furthermore, there are two vessels in process of construction at Messrs. Palmer's Yarrow-on-Tyne shipyards, which are equipped with inclosed engines. Both of these systems of propulsion promise well, so that the Admiralty have decided to await events before deciding the question.

During the coming year the personnel of the navy will have to be augmented by 4000 men to man the new ships, bringing the actual fighting strength up to 131,100 men. The naval reserve is being considerably strengthened by the establishment of numerous centers at various points round the coast, obsolete third-class cruisers being depositioned to serve as drill ships.

The present vessels in the fleet are also being extensively overhauled and modernized in accordance with present requirements as rapidly as possible. These ships are being practically reconstructed and provided with as formidable a modern armament as their capacities warrant.

During the past year experiments have been conducted incessantly with oil fuel. Progress has been somewhat slowly, but has been exceedingly sure. There are innumerable difficulties at present to be overcome if oil fuel is to prove possible, but these problems are being gradually surmounted. The British naval department is sanguine that oil fuel is destined to play a very important part in naval affairs. Simultaneously with these experiments the question of the storage of this fuel is being closely studied and developed. The experience gained in this direction with the battleships Mars and Hannibal with their cylindrical boilers has been utilized in connection with the Belleville boilers of the Bedford.

At the same time the policy of composing the various squadrons into homogeneous divisions of battleships is being zealously pursued. This is particularly the case concerning the Channel, Mediterranean, and China fleets. It is recognized as imperative, if a squadron is to prove efficient, that all the ships should be standardized as regards their speed, etc.—*Scientific American.*

It is rumored on apparently fairly trustworthy authority that Mr. Watts' Lord Nelson class will not be built as designed. They will be larger than the King Edwards, still, perhaps, but the pairs of 9.2-inch's are likely to disappear. Possibly 10-inch guns will take their place, as in the new Japanese battleships, but more probably they will carry four 12-inch, four 9.2-inch and ten 7.5-inch. The 6-inch gun is out of favor, and nothing is likely to resuscitate it now.—*Engineer.*

On Tuesday, the House of Commons went into committee of supply on the navy estimates, and on the vote of £3,646,000 for armaments, Mr. Gibson Bowles suggested that 9.2-inch guns should be substituted for 7.5-inch guns in our cruisers, and Mr. Lucas, who referred to the important part which torpedoes had played in the naval warfare in the Far East, asked whether efficiency in the management of torpedoes was specially encouraged by the Admiralty. Mr. E. Robertson drew attention to the growth of the vote, which exceeded last year's estimate by £500,000, and took the opportunity to observe that the conrtibutions of the Colonies to the navy did not amount to 1 per cent of the total cost. Replying to these and other speakers, Mr. Pretyman stated that the question of gunnery was being considered carefully by officers in the Mediterranean and Channel fleets, and that it was recognized that where possible the caliber of guns should be 7.5-inch rather than 6-inch. The Admiralty had accordingly already decided to make some changes. In the Devonshire or improved County

class of cruisers the four forward 6-inch guns were being replaced by two 7.5-inch guns with greater command, and in four of the six vessels in the Duke of Edinburgh class four 7.5-inch guns on the upper deck would be substituted for ten 6-inch guns. He assured the committee that under the new arrangements skill in the use of torpedoes was encouraged just as much as skill in gunnery. He agreed that the war in the Far East had clearly shown the great value of the torpedo as a naval weapon.

On the vote of £5,062,800 for shipbuilding materiel, Mr. Pretyman explained that if an accident happened to a submarine she would rise to the surface unless the accident was very serious and a large volume of water rushed into the vessel, in which case those on board would be killed at once. The submarines now being built, he informed the committee, cost roughly £40,000 each. It was as yet too soon to form a sure opinion as to the value of submarines in warfare. Before that could be done further experience must be gained. We were building only half the number of submarines that France was building.—*United Service Gazette.*

During the first week in April the bought battleship Swiftsure, built at Elswick by Sir W. G. Armstrong, Whitworth & Co., carried out successful speed, gunnery and torpedo trials in the presence of a large staff of Admiralty officials and representatives of the fleet reserve. After leaving dock at Chatham 1000 tons of coal were put on board the vessel, and water ballast was added until the draft of the vessel reached 24 feet 10 inches, or 4 inches in excess of her normal draft. The 30 hours' duration trial began on April 25, and throughout this trial the engines, by Messrs. Humphrys, Tennant & Co., ran at 130 revolutions and developed a power of 8700 horses, or just over three-fifths of the contract power. During the trial a considerable sea was running, with a fresh easterly breeze. Four runs were made on the measured mile off the mouth of the Tyne before the conclusion of the trial, and these runs gave a speed of over 17.5 knots, the revolutions being slightly above 130 and the H. P. 8670. The air pressure in the stoke-holds during the 30 hours was nil. The ship was anchored off the Tyne until the morning of April 29, additional water ballast having been taken on board during the interval. The six hours' full speed trial was then begun, with the vessel at a draft of 24 feet 7½ inches. During the six hours' trial six consecutive runs with and against the tide were made over the measured course; the mean speed of these runs worked out at 20.05 knots with 151 revolutions, I.H.P. 13,470. The mean H. P. during the whole of the six hours worked out at 14,018, so that the speed obtained on the six runs would be more than maintained throughout the rest of the trials. The gunnery and torpedo trials were proceeded with on the 30th, and, although so extensive, were completed in a day. The guns passed through the usual service trial, and one of the 7.5-inch guns and two of the 10-inch guns were also selected for rapid firing at a target. During these trials for rapidity the ammunition was served exactly as it would be served in action, and everything was carried out under the same conditions. The guns were worked by men from the Elswick works, but a trained captain of the turret was lent from the Excellent to do the actual shooting. The accuracy of the shooting and the rapidity of the firing were entirely satisfactory. Although several rounds from the 10-inch guns were fired right over the decks fore and aft, no damage was done to the structure or fittings of the vessel in spite of this severe test. The torpedoes were fired from the submerged torpedo tubes at speeds of 15, 16 and 17½ knots. These are the first trials of the Elswick submerged torpedo tubes in a British ship. The Admiralty torpedo officers were perfectly satisfied with their performance.—*United Service Gazette.*

The new first-class armored cruiser Devonshire was launched on the 30th of April at Chatham dock-yard. Her principal dimensions are as follows:

Length between perpendiculars, 450 feet; beam, 68 feet 6 inches; draft, forward, 24 feet 3 inches; draft, aft, 25 feet 3 inches; freeboard, forward, 20 feet 6 inches; freeboard, amidships, 14 feet 6 inches; freeboard, aft, 16, feet with a displacement of 10,475 tons. The first keel-plate of the Devonshire was laid on March 25, 1902, but her construction was delayed for some time in consequence of alterations being made in her design.

The principal protection to the vessel will be afforded by a belt of armor extending along the ship's sides for a length of 295 feet, from 6 feet 6 inches above the water-line to 4 feet 3 inches below. The thickness of this armor, which is of hard steel, varies from 6 inches to 4½ inches. The armor bulkhead at the after end of the belt is 4½ inches thick, and the protective plating on the bow 2 inches thick. The four barbettes are circular in plan, protected by hard steel 6 inches thick, while the fore conning tower has 10 inches hard steel armor. The whole of this armor was manufactured by Sir W. G. Armstrong, Whitworth & Co. The casemates for the 6-inch guns on the main and upper decks have 6-inch armor. The plates at the back are 2 inches thick. The main deck plating from the stem to the armor bulkhead is worked in two thicknesses, each of ½-inch before station 23, and ⅝-inch each abaft. Over the engine room a third thickness of ¾-inch is worked. On the lower deck from the stem to the armor bulkhead is worked two thicknesses of plating, each of ⅜ inch in thickness, and abaft the armor bulkhead there are two thicknesses of 1 inch thick.

The armament consists of four 7.5-inch Q. F. guns on turntables in the circular barbettes, with all-round loading mountings by Sir W. G. Armstrong, Whitworth & Co. The guns are protected by shields, having 7½-inch, 5½-inch and 4½-inch armor, with 2 inches on the floor and crown. There are also six 6-inch Q. F. guns, four on casemates on the main deck, and two in casemates on the upper deck, together with one 12-pounder on the upper deck, one 12-pounder field gun on the upper deck, twenty-three 3-pounder Hotchkiss guns on the upper deck, fore bridge and after shelter, and two .303 Maxims on the upper deck. The after, main and upper deck casemate guns have a fire direct aft. It may be pointed out that the vessel was originally designed to carry two 7.5-inch guns and ten 6-inch guns, but it has been decided to add two more of the heavier weapons and reduce the number of 6-inch guns by four. There are two submerged tubes for firing 18-inch torpedoes forward. The ship will carry nine 18-inch torpedoes and four 14-inch, the latter for firing with dropping gear from the ship's steam pinnace.—*United Service Institution.*

By the launch of the Sapphire from Palmer's yard at Jarrow, on March 17, the last of the third-class cruisers in hand is put into the water, the Diamond, her sister ship, having left the slips at the works of Messrs. Cammel, Laird & Co. at Birkenhead on January 6 last. The three third-class cruisers provided for in last year's program are not to be proceeded with, so that it may be assumed that we are not to have any more of this type. In all probability the new "scouts" will now take the place of third-class cruisers. It will be remembered that as a result of the experience of the maneuvers last year the view was formed that small vessels of slight sea-keeping capacity and medium speed were of little value. The scouts will have at least from four to five knots more speed than the Gem class, and the latter have, moreover, less coal capacity and a small range of action. The Sapphire is to be fitted with ten boilers of the Reed water-tube type, and her engines are estimated to be capable of 9800 horse-power. The Amethyst, one of this class, is being fitted with turbine machinery, and valuable experience should be obtained when these vessels make their experimental trials.—*Army and Navy Gazette.*

We recently referred to the new Admiralty scheme for educating engine-room artificers. The Bellerophon and Temeraire are being fitted up under the superintendence of Engineer-Captain Haddy, R.N., as instruction ships. The work was undertaken by Palmers' Shipbuilding & Iron Company, Limited, Jarrow-on-Tyne. The Admiralty last January placed these battleships in the hands of this firm for the purpose of transforming them, as just stated, into training ships and workshops. The amount of work involved was very large and of a special character, but it has been completed with great rapidity. The Bellerophon left the Tyne on March 29, the Temeraire will follow about ten days later. Some idea as to the extent and nature of the work may be gathered from the following outline of the principal alterations which have been effected in these vessels. The Bellerophon has been turned into a training ship for boys. The conning tower has been removed, also the after funnel and the boilers in the after boiler space; the opening being filled up. A corrugated iron house—about 200 feet long, 50 feet wide and 21 feet high—has been erected containing a machine shop with a large number of new machines, lathes, etc.; these machines are driven by two 20 horse-power electric motors. In addition, there are a drawing-office, model-room, gymnasium and cabins for officers and masters. On the main deck, after removal of the engines—a most tedious and difficult job—and making good the deck, have been placed a workshop, reading, recreation and mess-rooms, and at the after end is a school-room complete with desks, seats, etc., for about 100 boys. On the lower deck extensive and commodious wash-places have been fitted, and racks for hammocks, stores, etc. In the boiler room, from which the boilers have been removed, has been fitted a blacksmith shop, containing sixteen forges and anvils, a motor hammer and some coppersmiths' fires, the smoke from which is led into a central funnel which is fitted with an exhaust fan. All the compartments are lighted by electricity. In the case of the Temeraire, the engines and the boilers in the after boiler room have been removed, and the spaces decked over. On the lower deck are fitted a carpenters' workshop, store rooms, issue rooms, offices, etc., while a large baggage port has been cut through the side armor and teak backing. Shipwrights' and joiners' shops, together with the plumbers' and fitters' workshop and the necessary machines, have been fitted on the main deck, where also are placed an electrical shop with lathes and other equipment and various store rooms. On the upper deck the after funnel and casing and the conning tower has been removed and skylights fitted over the electrical and other rooms. The forward barbette contains the dynamos which generate the current both for lighting and driving the various motors in this vessel and in the Bellerophon, which vessels, together with the Indus, are to be moored in tandem fashion at the dock-yard, connection between the three being by means of substantial bridges. From the foregoing it will be seen that the work has been of an important nature. The whole of the work has been completed in the short time of eight weeks, which speaks well for the energy and resources of the Palmer Company, and also indicates what could be accomplished during the storm and stress of war time.—*Engineer.*

The Sentinel, the first vessel of the new scout class, was launched on April 19 from the shipbuilding yard of Messrs. Vickers, Sons & Maxim, Limited, at Barrow. The ceremony was performed by Miss Hay, daughter of one of the directors of the company. The Sentinel is 360 feet long, 40 feet broad and has a mean draft of 14 feet 2 inches. Her displacement at that draft is 2920 tons; her estimated horse-power is 17,000; and her maximum speed with forced draft is to be 25 knots on the contractors' trial in smooth water. Her armament consists of ten 12-pounder and eight 3-pounder quick-firing guns. Her coal capacity is 150 tons, which is estimated to give her a coal endurance of

4000 miles at cruising speed, but will, of course, give her a much smaller radius of action at full speed. Her total estimated cost is given in the navy estimates as £276,384, which is approximately the cost of the second-class cruisers of the Talbot class, with a displacement of 5600 tons and a speed of 19 to 20 knots. She will have a complement of 286 men. A feature of the vessel is an ammunition passage under the upper deck, which gives the crew transporting the ammunition from the magazine to the guns the protection of the shell plating and the coal in the bunkers. There are 12 boilers, arranged in three water-tight compartments.

The new shallow-draft gunboat Widgeon, for river service, was successfully launched from Messrs. Yarrow's works at Poplar on Saturday. The vessel is 160 feet in length, by 24 feet 6 inches beam, and the draft, carrying a load of 40 tons, 29 inches. She is fitted with twin screws working in tunnels on the raised propeller system, with Yarrow's patent flap arrangement, by which the maximum efficiency of propulsion is obtained under all conditions of load.—*United Service Gazette.*

The statistical report on the health of the navy for 1902 has been issued, and is considered, on the whole, satisfactory. The total number of deaths was 590, as compared with 526 in 1901. The highest death-rate was on the Pacific station, where it was as high as 67.52 per 100; not, however, from sickness, but owing to the loss with all hands of the Condor. The station, indeed, showed the lowest sick-rate of any. he highest sick-rate was on the East Indies station, where it was 44.27 per 1000. The irregular force with 43.04 ran it very close, however. The total number of cases of disease and injury entered on the sick list was 85,769, and the average number of men sick daily 3523.39. Of the deaths, 350 were from disease and 240 from injury. Wounds and injuries were responsible for 16,383 cases, resulting in 225 deaths, and diseases of the digestive system were responsible 13,614, resulting in 27 deaths. Only two wounds in action are recorded, with one death, only one case of plague, which terminated fatally, and five cases, four fatal, of cholera on the China station. The total force serving afloat was 99,600, and the average loss of service from disease and injury represented 12 days for each person.—*Army and Navy Gazette.*

During the trials of H. M. S. Cornwall, which is fitted with Babcock & Wilcox boilers, the following results were obtained:

Thirty hours at 16,000 horse-power, indicated horsepower, 16,487 = 21.835 knots, consumption 1.69.

Eight hours at 22,000 horse-power, indicated horse-power 22,694 = 23.687 knots, consumption 1.94.

The piston speed on the eight hours' trial averaged 1041 feet per minute, 21 feet per minute more than in the Swiftsure and Triumph. The Cornwall, like the Lancaster, was engined by Messrs. Hawthorn, Leslie & Co., who have engined more "flyers" than any other firm. The Cornwall was built at Pembroke dock-yard. The other recent County class ship engined by the same firm is the Lancaster, built at Elswick, and fitted with Belleville boilers. The Elswick ship on trial obtained a better speed than her dock-yard built sister, the results being:

Eight hours full power.

Lancaster, indicated horse-power 22,881 = 24.01 knots, 147 revs.
Cornwall, indicated horse-power, 22,694 = 22.69 knots, 148 revs.

Difference in speed.....1.32 knots.

On the thirty hours at four-fifths power the two were about equal, the figures being:

Lancaster, indicated horse-power 16,044 = 22.05 knots, 134 revs.
Cornwall, indicated horse-power 16,478 = 21.83 knots, 135 revs.

The Elswick ship being a revolution to the good, as well as a knot swifter on the eight hours full speed. On another occasion the Lancaster did still better, exceeding 24.1 knots for the whole eight hours. It is a pleasing record for Tyneside construction that it should be able to boast the swiftest of the Counties, especially when it is borne in mind that till the Lancaster, Elswick had for a long time been off the Admiralty list.—*Engineer.*

In the cruiser squadron "race home" the Berwick had a tube burst, which killed one stoker and seriously injured another. She is the Niclausse boilered ship of the squadron, and this mishap put an end to the competitive tests between that type and the Belleville, as the squadron stopped to bury the victim. At present all that is known is that the Drake and Good Hope proved extremely economical, while none of the County class shone in that direction. On the other hand, the County class ships, especially the Donegal, complained considerably of the raw stokers with which they were inundated. Sir Charles Dilke recently drew attention to the stoker question in Parliament; but very little result is apparent. Trained stokers are scarce, and of such as there are, practically all the spare men are Belleville trained. These are put into ships with other types of boilers, where they naturally succeed only indifferently, and the Belleville ships left to shift with raw material. This in many cases does not greatly matter according to all accounts, as the raw hand presently "tumbles to his job," but one or two ships with other types of boilers who have been given the Belleville trained stokers claim this as a cause of trouble. "One stoker, one boiler," they cry. If this is the latest, we ought to have a pretty varied selection of stoker training establishments by-and-by. But perhaps the real cause lies elsewhere.—*Engineer.*

H. M. S. Erne is one of five torpedo-boat destroyers, the construction of which was recently entrusted by the Admiralty to Messrs. Palmers' Shipbuilding & Iron Company, Jarrow-on-Tyne. Whilst the Erne presents some of the newest features in the science of warship building, there has been no attempt to attain record speeds, for it has been proved that to obtain a high rate of running the hull must necessarily be built on somewhat slender lines, and this in a heavy sea is maintained to be a doubtful advantage. The Erne is 225 feet long, with a breadth of 23 feet 6 inches. In this class of vessel the displacement has been increased from 360 to 560 tons, and an extra deck has been worked in for the length of the forecastle—thus affording better accommodations for the crew—and also increasing the height of the forward gun platform which is mounted thereon, and thereby improving the range of vision of the captain of the gun. The machinery consists of twin-screw triple-expansion engines of Messrs. Palmers' usual type for these vessels, steam being supplied by four Reed's patent water-tube boilers, placed in three stokeholds—the middle stokehold containing two boilers face to face. Steam is generated by these at a working pressure of 250 lbs. per square inch and carried to the two sets of triple-expansion engines, which have cylinders of 20 inches, 31 inches and 48 inches in diameter and 19½-inch stroke. Working at 350 revolutions per minute the indicated horse-power is about 7000. Air is supplied to the boiler furnaces by six fans of 6½ feet diameter, working at 450 revolutions per minute—the bearings being kept cool by running in oil under forced lubrication. This method is also adopted in the case of the electric-light engine, which runs at 450 revolutions, and supplies the current for the searchlight placed on the bridge—as also for the internal lighting of the ship—and for driving two motor fans for ventilating the crew spaces forward. The armament consists of one 12-pounder mounted on the conning tower forward, and five 6-pounder quick-firing Hotchkiss guns—

four of these being on the broadside and two on the raised central platform aft. The ammunition is stowed in magazines at the fore and aft ends of the ship, under the men's and officers' quarters. There are two torpedo tubes, one forward and one aft, on the upper deck on the center line of the vessel, which can revolve and thus fire a torpedo to port or starboard without turning the ship round. These are provided with 18-inch torpedoes of the latest type, fitted with gyroscopes, which enable them to run "true" for 3000 yards. The principal difference between this vessel and the previous boats of this class is the high forecastle instead of the turtle-back deck, which makes the Erne a better sea boat, as it gives a much higher bow for driving against a head sea. The use of high tensile steel has also been adopted in the construction of this vessel, to a very much greater degree than hitherto. The contract speed of the Erne was 25½ knots, a speed which was maintained—and exceeded—in the course of some recent sucessful trial trips. The complement is made up of 4 officers and 66 men, one officer and 44 men of this number being for the engine room and stokeholds. The capacity of the coal bunkers is 130 tons, which enables the boat to steam 450 miles at full speed, or 3000 miles at the economical speed of 13 knots. There are five boats, comprising a whaler and dinghy slung on davits, and three collapsible Berthons stowed on the deck.—*Engineer.*

A correspondent sends home some interesting particulars as to the coaling records of the Cruiser squadron of the Mediterranean fleet. The Pyramus was, he says, again to the fore in the matter of coaling from a collier at Argostoli on March 21. This ship held the record for her class previous to this, with 65 tons per hour at the same port in November of last year. This remained good until H. M. S. Pandora beat it on March 20 with 78.3. Captain Grafton had the ship's company fall in, and told them that their last good coaling was beaten, and expressed a wish that as the Pandora had just finished and the Pyramus was about to start, they should only be allowed to hold their new record at the most for two hours. The result was more than satisfactory. The order to commence was given at 15 minutes past 5, and by 6 o'clock 69 tons had been stowed away in the bunkers. This result encouraged the "hands" to greater efforts, and in the language of the lower deck, "Every officer and man did his level." At 7 o'clock the order was passed to cease coaling. Then, with a cheer, the ship's company heard that 101 tons had been in during the last hour, thus creating a splendid record of 97.1 tons per hour. This will undoubtedly be hard to beat, and Captain Grafton and officers are to be complimented on this fine performance. Admiral Sir Baldwin Walker signaled: "I congratulate you on your fine coaling," and the Pandora, who had just been beaten, signaled: "Congratulations—101 an hour is a little beyond us, I am afraid." The coaling of the cruisers here is as follows: H. M. S. Bacchante, 111.27; H. M. S. Pyramus, 97.1; H. M. S. Pandora, 78.3; H. M. S. Aboukir, 78; H. M. S. Furious, 73.5; H. M. S. Naiad, 24. H. M. S. Naiad only took in 40 tons and swept out the collier.—*United Service Gazette.*

In connection with the new scheme of naval training, whereby the present training ships will be abolished and shore quarters established for young seamen, the Admiralty have recently acquired a site abutting upon Fareham Creek, about 130 acres in extent, and upon this will be erected a training school for the boys of the St. Vincent It may be remembered that in the House of Commons last week, Mr. Arthur Lee defended the policy of the Admiralty in this respect, and mentioned that the increased vote for naval barracks was required for two establishments about to be proceeded with. Evidently the St. Vincent barracks is one of them.—*United Service Gazette.*

The cruiser Medusa last week received her first complement of boys from the Impregnable, training ship at Devonport, to carry out the new scheme of sea training for boys. The cruiser takes the place of the brigs Liberty, Nautilus and Pilot, on board which the boys from the training ships have hitherto received instruction at sea. Under the new scheme the boys will be trained in gunnery, seamanship and stokehold duties, and mechanics. The Medusa left Devonport on Monday for the first daily cruise under the new system, and will go out each week on Monday, Tuesday, Wednesday and Thursday, remaining in harbor on the other days. She will draw her complements from the Lion and Black Prince, training ships, as well as from the Impregnable.—*United Service Gazette.*

TRIALS OF THE WELLAND AND RIBBLE.—The Welland and Ribble, torpedo-boat destroyers, which have been built by Messrs. Yarrow & Co., of Poplar, have carried out a successful series of steam trials off Dover during the past fortnight. In her four hours' coal consumption trial at full power the Welland obtained a mean speed of 25.349 knots for three hours, the I. H. P. developed being 7678, and the revolutions 343 port, 334.4 starboard. The mean results obtained on six runs over the measured course were: Speed, 25.486 knots; I. H. P., 8003; revolutions—starboard, 344.9; port, 338.1. The coal consumption worked out at 1.65 lbs. per I. H. P. per hour. This was followed by a four hours' full speed trial, which proved very satisfactory. During three hours a mean speed of 26.244 knots was obtained, with the engines developing 7766 I. H. P. The revolutions were—starboard, 346.2; port, 338.4. Almost identical results were obtained on six runs over the measured mile, the speed being 26.016 knots, and the I. H. P. 7754. The trials of the Welland were brought to a conclusion with a 12 hours' coal consumption trial, during which the coal consumption was 1.47 lbs. per I. H. P. per hour, for a mean speed of 13.505 knots.

The Ribble also did remarkably well. On her four hours' coal consumption trial the mean results for three hours were: I. H. P. 7634; revolutions—starboard, 339.3; port, 335; speed, 25.485 knots. During six runs over the measured course the speed was 25.328 knots, and the I. H. P. 7733. The coal consumption was 1.57 lbs. per I. H. P. per hour. Her four hours' full speed trial was carried out on Thursday, when the mean results for three hours were: I. H. P., 7430; revolutions—starboard, 342.7; port, 336.8; speed, 25.820 knots. The speed on six runs was 25.817 knots, with the engines developing 7696 I. H. P. The vessel left for her 12 hours' coal consumption trial yesterday. A feature of the trials was the low coal consumption and the smooth running of the machinery.—*London Times.*

A return of casualties to British warships during the year 1902 has just been issued as a Parliamentary paper. It shows that there were accidents—chiefly collisions—to three first-class battleships, the Mars, Formidable and Irresistible, and fourteen torpedo-boat destroyers, fifteen persons in all being killed and nine injured. In three cases, those of the destroyers Haughty, Angler and Cheerful, damaged by contact with other destroyers while at anchor at Greenhithe, proper care was not taken to insure the safety of the vessels. A gun accident during target practice on the battleship Mars, from which twelve deaths occurred, was found to be due to neglect to close the breech-block of the gun after misfire. The Recruit destroyer collision was attributed to an error of judgment on the part of the lieutenant in command. In the other accidents no blame was attributable.

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A year ago twenty-one tons of coal were selected at Portsmouth for naval experimental purposes. The coal was divided into three portions—

two of ten tons each and one of one ton. One of the ten-ton lots was divided into five heaps, which were covered with tarpaulins and left at the coaling point in the dock-yard. The other ten tons were placed in five cases, which were submerged in No. 2 basin. The remaining ton was burnt, and careful calculations made of its calorific properties. One of the submerged crates has now been raised, and the coal is to be burnt in one of the boilers houses in the dock-yard. A comparison will then be made by burning the coal in one of the mounds at the coaling point, and it is expected that valuable data will be obtained as to the preservative action of salt water as compared with the exposure of coal to the air. Subsequently the remaining mounds and cases of coal will be burnt under carefully observed conditions.

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Advantage is being taken of the refit of the Majestic at Portsmouth to make an important alteration in her secondary armament. It has been found that the two 12-pounder guns mounted right forward on the main deck are so close down to the water line that in moderately rough weather it is really impossible to use them. It has, therefore, been decided to remove these guns and to replace them by four 12-pounders, two on each side of the forward end of the superstructure. This will be a great advantage, for not only will the guns be available in all conditions of weather, but their area of fire will be much greater, so that even for torpedo-boat attack, for which these weapons are really carried, they will be more serviceable. Similar alterations are to be made in all the ships of the Majestic class, as they come into dock-yard hands for refit.—*United Service Gazette.*

The May issue of the *United Service Magazine* is remarkable for an article on discipline in the navy, by a writer who prefers to be known as "Ward Room." It is a striking rejoinder to the "humanitarians" who wish to see flogging in the navy totally abolished. Taking as his text the court-martial returns for 1902, the writer proceeds to show that 53.8 per cent of the whole of the serious crimes in the navy are to be classed under the heading of striking or attempting to strike superior officers. It is difficult, as "Ward Room" says, for the civilian mind to grasp the gravity of these crimes, because ashore a man may take the law into his own hands, and the infliction of a small fine or an injunction to keep the peace meets the case. But afloat, the superior officer is very much like a defenseless person, for, bad as it is for an inferior to strike one above him, it is far worse for that superior to forget his position and strike back. To this poison of insubordination, which "Ward Room" claims is fast spreading through the fleet, he offers the antidote of the "cat."

"Many of the offenses of striking could be very well dealt with by the 'cat,' and the services of the offender retained; and at the same time the fear of physical pain would have an excellent deterrent effect, especially on cowardly natures. . . . It is certainly a pity that the brutality of the past should be a bar to the merciful administration of corporal punishment in the present."

A particularly interesting letter, written by Lord St. Vincent, and dated November 9, 1800, appears in the catalogue of an Edinburgh bookseller. The interest centers in the curious reference to Nelson, which is scarcely in consonance with the general idea of St. Vincent's views in this connection. The quotation is as follows:

"It is evident from Lord Nelson's letter to you on his landing that he is doubtful of the propriety of his conduct. I have no doubt he is pledged to getting Lady H[amilton] received at St. James', and every where, and that he will get into much Brouillerie abt it. Troubridge says Lord Spencer talks of putting him into a two deck ship. If he do's, he must give him a separate command for he cannot bear confinement to

any object, he is a Partizan, HIS SHIP ALWAYS IN THE MOST DREADFUL DISORDER, AND NEVER CAN BECOME AN OFFICER FIT TO BE PLAC'D WHERE I AM."

[Enclosed with this letter is one from Sir John Henslow to Earl St. Vincent regarding the construction, etc., of ships of war.]

With reference to this matter of the discipline of Nelson's ships, it may be remembered that in the Creevey correspondence there is a letter dated 1806 from Graham Moore, saying that he had got a draft of the Victory's men, and that they were a very rough lot, but he hoped soon to get them into order. In a way this might be held to corroborate St. Vincent's opinion. We shall be glad to learn if any of our readers have come across similar letters.—*Army and Navy Gazette.*

A correspondent in the Mediterranean fleet, writing from Malta, says: Torpedo tubes, like guns, have now become quick-firing, two or three ships having recently fired four rounds from one submerged tube in less than a minute and three-quarters. This may not appear credible, but it is an absolute fact. It is to be hoped that one or two submarines will soon be posted here and at Gibraltar. The straits or channels at either place are not very wide, and as offensive weapons the value of submarines to us would be immense.—*United Service Gazette.*

The Prince and Princess of Wales, who arrived at Portsmouth on Saturday last on a private visit to Admiral Sir John Fisher, embarked on board the Mercury on Monday, and steamed out to a point off Bembridge to witness maneuvers between the Home fleet and submarines. The Home fleet, under Vice-Admiral Sir A. K. Wilson (whose flag flew in the Revenge), was supposed to be about to attack Portsmouth, and the defending destroyers and submarines had to endeavor to prevent the "enemy" entering Spithead. The Mercury did not go far into Sandown Bay, but lay near the Nab Lightship. When she arrived the destroyers and five submarines were already in the bay, but the Home fleet was invisible. Eventually ten battleships and cruisers appeared, advancing in single line up the Channel, screened by a large force of destroyers. The defending vessels immediately proceeded to meet the enemy, each submarine sheltering under the lee of a destroyer. By noon the attack developed, the destroyers coming into action and firing briskly. The battleships and cruisers also joined in, whereupon the submarines dived. The defending destroyers beat a hasty retreat, taking refuge near imaginary land forts. Left to themselves, the submarines made for the large ships, but the destroyers prevented them from torpedoing at an effective range, and claimed that the fleet was completely protected. Two submarines lost their periscopes, became practically useless for attack, and fired no torpedoes. When the attack was over the umpires collected the evidence. The flagship Revenge accompanied the Mercury to Spithead and anchored, Admiral Wilson going aboard the Mercury to lunch with the Prince of Wales. The Mercury then steamed into harbor, the submarines accompanying and performing diving and other evolutions, which the Prince of Wales watched closely. On Tuesday their Royal Highnesses paid a visit to the Royal Naval College at Osborne, and also to Osborne House and other places in the Isle of Wight; and on Thursday the Prince inspected the Royal Marine Artillery at Eastney, and the Princess afterwards laid the foundation stone of a new Corps church to be built close to the barracks there.

It is announced at Portsmouth that the umpires have upheld Captain Bacon's claim that his submarines torpedoed four battleships in the operations off the Isle of Wight on Tuesday evening last week. The submarines have done excellent work during the maneuvers, and so far only one of them—No. A1—has met with a slight mishap. The confidence placed in them is shown by the fact that they are used at night.—*United Service Gazette.*

ITALY.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Roma	12,625	Gov't Yard, Naples.	Building.
Napoli	12,625	Gov't Yard, Spezia.	"
X	12,625	Gov't Yard, Castellamare.	Projected.
Vittorio Emanuele	12,625	Gov't Yard, Castellamare.	Building.
Regina Elena	12,625	Gov't Yard, Spezia.	Launched June 19, 1904.
Armored Cruiser.			
Francesco Ferruccio	7,460	Gov't Yard, Venice.	Under trial.

The Italian Navy Budget for the year July 1, 1904, to June 30, 1905, is £5,087,643, being £373 more than the previous financial year, which is due to the fact that the sum in hand at June 30 will be greater by that amount. The total amount available for the building of new ships will be £1,533,469. This sum will be devoted to the completion of the cruiser Francesco Ferruccio; the further construction of the battleships Vittorio Emanuele, Napoli, Regina Elena, and Roma, the first at Castellamare, the second at Naples, and the remaining two at Spezia; the laying down of a new battleship or cruiser at Castellamare; the building of three submarines of the Glauco type at Venice; the completion of the two torpedo-boat destroyers Zeffiro and Espero at Naples and at Pattison's yards; the building of 14 first-class torpedo-boats, and of various auxiliary vessels.—*U. S. Gazette.*

JAPAN.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Kashima	16,500	Vickers.	Building.
Katori	16,500	Armstrong.	"
Armored Cruisers.			
1, 2, 3	9,900		Projected.
Protected Cruisers.			
1, 2	5,000		Projected.
Hitaka	3,470	Yokosuka.	Launched.
Tsuchima	3,470	Kure.	"
Otawa	3,000	Yokosuka.	"

The London correspondent of the *Glasgow Herald* publishes some particulars of the two very powerful battleships to be built for the Japanese navy, the one by Vickers, Sons & Maxim (Limited), at Barrow-in-Furness, and the other by Sir W. G. Armstrong, Whitworth & Co., at Elswick. In addition to four 12-inch guns mounted in pairs within barbettes of 9-inch hardened steel, there will be in the four quarters of the upper deck a 10-inch gun within barbettes of 6-inch armor, and covered, like the 12-inch guns, with armored hoods. Within the battery on the main deck there will be on each broadside five 6-inch guns, and centrally situated on each side on the upper deck one more of the same caliber, making in all twelve guns of 6-inch caliber. Conveniently placed for repelling torpedo and submarine attack, there will be twelve 12-pounder guns, three 3-pounders and six Maxims, with the addition of six under-water torpedo-firing tubes. This is the most powerful gun battery yet decided upon for a battleship, as 10-inch guns take the place of 9.2-inch weapons in the King Edward class, while there are also two additional 6-inch quick-firers. As the 10-inch guns fire 500-lb. shot, with an energy of 28,000 foot-tons as compared with the 20,000 foot-tons of the 380-lb. shot got with the best of 9.2-inch guns, some idea of the greater power can be

formed. The general lines of armor protection, incorporated for the first time in the Mikasa, built by the Vickers Company, will be followed and extended. The water-line belt will be 9 inches thick, then to the level of the upper deck there will be 6-inch armor; but in addition there will be introduced, for the first time, 4-inch armor above the level of the upper deck, so that there will be no part of the upper works unprotected except for a length of about 80 feet forward and 88 feet aft. The guns behind the broadside armor will be separated by armor bulkheads. The 12-inch guns are to be 26 feet above the load water-line, the 10-inch guns 22 feet, and the main deck 6-inch guns 14 feet. The sea speed is to be 18½ knots, attained with twin-screw four-cylinder triple-expansion engines, supplied with steam from 20 Niclausse boilers. The total coal capacity will be 2000 tons, so that no feature of importance in the fighting capabilities of the ship has been forfeited to give the great primary elements of offense and defense indicated; and yet the dimensions are not excessive. The length of 455 feet is 30 feet greater than in the case of recent British battleships; but beam and draft are about the same—78 feet 2 inches and 26 feet 7½ inches respectively. These latter are important limitations to be aimed at now, as few of our docks can take vessels exceeding 78 feet. It may be all right to have merchant vessels trading only between certain ports of greater beam when there are suitable dimensioned graving docks available at these termini; but warships may have to be docked at the nearest port to the scene of their mishap, and thus it is of advantage to minimize beam. The displacement is 16,400 tons, about the same as the King Edward class. The particulars given will form interesting comparisons with the forthcoming designs of new British ships, where it is expected the gun power will be about the same.—*United Service Gazette.*

RUSSIA.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Emperor Paul I.....	16,000	St. Petersburg. (Baltic Yard.)	Building.
Andrei Pervosvannui..	16,000	St. Petersburg. (Galerney Island.)	"
Imperator Alexander III.	13,516	St. Petersburg.	Under trial.
Borodino	13,516	"	"
Orel	13,516	"	"
Kniaz Suvarof	13,516	"	"
Slava	13,516	"	Launched Aug. 29, 1903.
Evstafi.....	12,500	Nicolaiev.	Building.
Ivan Zlatoust	12,500	Sevastopol.	"
Coast Defense Iron Clad.			
Admiral Boutakof.....	6,000	St. Petersburg.	Building.
Protected Cruisers.			
Oleg	6,750	St. Petersburg.	Launched Aug. 27, 1903.
Kagul	6,750	Nicolaiev.	Launched June 2, 1903.
X	6,700	"	Building.
Otchakof	6,750	Sevastopol.	Under trial.
X	6,750	"	Building.
Vitiaz	6,750	St. Petersburg.	Building.
X	6,750	"	"
Boyarin.....	3,200	Copenhagen.	Under trial.
Kalgoula	3,200	Nicolaiev.	Building.
Almaz	3,200	St. Petersburg.	Launched June 2, 1903.
Zemtchug.....	3,200	"	Launched Aug. 27, 1903.
Izumrud.....	3,200	"	Launched Oct. 24, 1903.
?	3,200	Dantzic (Schichau).	Building.
8.....	3,200	St. Petersburg.	Projected.

The new Russian program of six Emperor Paul type ships seems likely to be increased to eight, with a number of Bayans in addition. It is said that they will be built in Germany; but France is more likely to secure the bulk of orders that go outside Russia. It is doubtful whether this country will get any, and America is practically certain not to, on account of the feeling now existing in Russia. Perhaps the same thing may be said of British firms, except for the action of the Talbot's captain at the battle of Chemulpo. This seems to have made a very favorable impression of impartiality in Russia, so possibly public feeling there may not be altogether against employing British firms. Certainly, if the Russians want ships quickly, this will be the country to apply to.—*Engineer.*

The *Yacht* asserts that it is now well ascertained that the new Russian shipbuilding program includes eight battleships of Imperator Pavel I class, 16,630 tons, 18,000 H. P., and eighteen knots speed, as well as several armored cruisers of the Bayan type. From the same source we learn that a destroyer of a new class is being constructed, its peculiarity being a double hull, the interspace filled with oil. The range of action will be 500 miles with coal and 450 miles with oil. The boat will soon be completed, and, if the trials should be successful, may be dispatched to the Far East.—*Army and Navy Gazette.*

The Russians, so far as we know, have so far lost three out of the twenty-five destroyers which they had in the Far East. There were four built at Elbing, and a fifth from the same yard captured from the Chinese at Taku, one built at Birkenhead, three at the Forges et Chantiers, Havre, two in the Normand Yard, Havre, two in the Neva establishments, and twelve at Port Arthur, of which the last to be put into the water was the Stratni, on November 25, 1903. The boats lost are the Steregustchi and Skory, both built at Port Arthur, one sunk in action and the other by fouling a mine in trying to enter the harbor. The third boat which has perished is the Vnushitelni, built at the Forges et Chantiers, Havre, which was driven on shore by the Japanese in Pigeon Bay and destroyed. It is now announced by the *Vossiche Zeitung* that the Russian government has invited tenders for the construction of twelve seagoing torpedo boats from the Germania, Schichau and Vulcan Yards, to be completed within a year. At the beginning of the present year thirteen such boats were in hand, as well as eighteen destroyers of about 300 tons. A correspondent at Nikolaieff says that the three destroyers Zorki, Zadorni and Zvouki have been completed there. It is stated that the Kaiser Friedrich, a German 20-knot steamship which has been laid up for some three years because of her great coal consumption, has been sold to Russia. She will be fitted as an auxiliary cruiser at Danzig, and then, as it is curiously stated, will proceed through the Suez Canal for Australia, but will alter her intentions after passing Colombo or Singapore.—*Army and Navy Gazette.*

SPAIN.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Protected Cruisers.			
Reina Regente.....	5,372	Ferrol.	Building.
Isabel la Catolica.	3,500	Canaca.	"

SWEDEN.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Coast Defense Battleships.			
Oscar II	4,208	Stockholm.	Building.
Manligehten	3,650	Malmö.	Launched.
Tapperheten	3,650	Stockholm.	"
Armored Cruiser.			
Fylgia	4,600	Stockholm.	Building.

UNITED STATES.

VESSELS BUILDING.

No.	Name.	Speed. Knots.	Where Building.	Degree of Completion May 1. per cent.	Degree of Completion June 1. per cent.
	Battleships.				
12	Ohio	18	Union Iron Works.	93	94.5
13	Virginia	19	Newport News Co.	59.4	61.2
14	Nebraska	19	Moran Bros. Co.	46.9	49
15	Georgia	19	Bath Iron Works.	52	54.1
16	New Jersey	19	Fore River S. & E. Co.	57.6	58.7
17	Rhode Island	19	Fore River S. & E. Co.	59.8	60.7
18	Connecticut	18	Navy Yard, New York.	38.5	42.1
19	Louisiana	18	Newport News Co.	47.9	49.3
20	Vermont	18	Fore River, S. & E. Co.	6.8	8.9
21	Kansas	18	New York S. B. Co.	7.5	9.6
22	Minnesota	18	Newport News Co.	26.2	29.6
23	Mississippi	17	Cramp & Sons.	2.3	3.5
24	Idaho	17	Cramp & Sons.	2.2	3.2
	Armored Cruisers.				
4	Pennsylvania	22	Cramp & Sons.	76.9	80.5
5	West Virginia	22	Newport News Co.	83.4	85.5
6	California	22	Union Iron Works.	60	60.5
7	Colorado	22	Cramp & Sons.	80.9	84.9
8	Maryland	22	Newport News Co.	78.9	82.3
9	South Dakota	22	Union Iron Works.	55.5	57.5
10	Tennessee	22	Cramp & Sons.	28.9	34.4
11	Washington	22	New York S. B. Co.	24.2	29.3
	Protected Cruisers.				
14	Denver	17	Neafie & Levy.	90.9	100
15	Des Moines	17	Fore River S. & E. Co.	100	100
16	Chattanooga	17	Lewis Nixon.	80	84.2
17	Galveston	17	Wm. R. Trigg Co.	78	81
20	St. Louis	22	Neafie & Levy.	41.2	42.6
21	Milwaukee	22	Union Iron Works.	48	50.5
22	Charleston	22	Newport News Co.	69.7	73.1
	Gunboats.				
17	Dubuque	12	Gas Engine & Power Co.	40	46.6
81	Paducah	12	Gas Engine & Power Co.	33.6	35.7

Orders have been given to expedite the preparation of the specifications for the battleship and two armored cruisers authorized by the last naval appropriation act, and it is now expected that the contracts for these three vessels will be advertised early in September. This action by the Department is acepted as showing conclusively that whatever weight should be given to the suggestions of prominent members of the Senate Naval Committee that no more battleships be built until opportunity has been afforded to study the lessons of the Russo-Japanese War, the Secretary of the Navy does not feel justified in disregarding the plain enactment of Congress.

It is possible that if more than a single battleship had been appropriated for an opportunity would have been given the House and Senate to reconsider the action taken, but as only one vessel of this type was authorized it is not regarded as judicious to establish a precedent for ignoring the statutes for the sole purpose of permitting Congress to take a second thought.

CHARACTERISTICS OF THE NEW BATTLESHIPS.—The general plans for the battleship will closely approximate those for the Connecticut and Louisiana, but in some respects there will be interesting departures. The value of the submerged torpedo as compared with the aboveboard installation is recognized in the plans and the latest type of this weapon will be installed. The general dimensions and features of the new battleship are as follows:

Length of load water line	450 feet.
Breadth, extreme, at load water line	76 feet 10 inches.
Displacement on trial, not more than	16,000 tons.
Mean draft to bottom of keel at trial displacement	24 feet 6 inches.
Gross draft, full load, about	26 feet 9 inches.
Total coal bunker capacity, about	2200 tons.
Coal carried on trial	900 tons.
Feed water carried on trial	66 tons.

The main battery of the battleship will consist of four 12-inch, eight 8-inch and twelve 7-inch breech loading rifles, while the secondary battery will include twenty 3-inch 14-pounder rapid-fire guns, twelve 3-pounder semi-automatic guns, six 1-pounder automatic guns, two 1-pounder semi-automatic guns, two 3-inch field pieces, two machine guns, caliber .30, and six automatic guns, caliber .30. The battery, both main and secondary, is still subject to modifications, but no change in the total weights is likely to be made. The engines will be of the vertical twin screw four-cylinder triple expansion type, aggregating 16,500 horse-power, and each engine will be located in a separate water tight compartment. There will be 12 water tube boilers, probably of the Babcock & Wilcox type, placed in six water tight compartments. A well equipped machine shop will be installed, the tools to be run by electric motors.

THE ARMORED CRUISERS.—The two first-class armored cruisers will be built after the general plans of the Pennsylvania and class, but a number of changes will be made to bring the equipment up to the latest approved naval practice. As in the case of the battleship, submerged torpedo tubes will be installed in the cruisers, and electric motors will be employed for the operation of auxiliaries and machinery wherever possible. The general dimensions of these vessels will be approximately as follow:

Length on load water line	502 feet.
Breadth, extreme, at load water line, about	70 feet.
Trial displacement, about	13,800 tons.
Mean draft at trial displacement, about	24 feet 6 inches.
Greatest draft, full load, about	26 feet 6 inches.
Total coal bunker capacity	2000 tons.
Coal carried on trial	900 tons.
Feed water carried on trial	75 tons.
Speed, not less than	22 knots.

The batteries of the cruisers have not yet been completely worked out, but will not differ greatly from those of the Pennsylvania and class, which included four 8-inch guns, fourteen 6-inch guns, eighteen 14-pounders, twelve 3-pounders, four 1-pounder guns, four 1-pounder rapid-fire guns, two 3-inch field guns, two machine guns and six caliber .30 automatic guns.

TURBINES FOR SCOUT SHIPS.—The plans for the hulls of the three scout vessels are being rather slowly worked out owing to the difficulties, heretofore referred to in this correspondence, that have been encountered in the endeavor to develop the required speed in connection with the limited tonnage and the necessary superstructure. The Bureau of Steam Engineering has gone ahead rapidly in the designing of the turbine engines and auxiliary apparatus, and this part of the task is well ahead of the hull designers. Whether the contracts for these vessels can be advertised on the same date with those for the battleship and armored cruisers cannot be predicted, but it is believed there will not be much delay. Rear-Admiral George W. Melville, retired, who has just returned to this country from a European tour devoted to an investigation of the development in the use of turbines abroad, has given out an interesting statement in which he forecasts a strong recommendation that he will make to the Navy Department with regard to the installation of turbine engines as the result of his recent observations. He says:

"We are 20 years behind the times in not having the turbines in operation. I shall recommend it to the navy, as I recommended it two years ago. Of course the limit of experimentation has not been reached, and in some ways the turbine may be said to be in its infancy. That is, no engineer would swear to it or guarantee specific results. But it is far past the stages of theory and the first stages of practical experiment, so much so that the Cunard line, although the shipbuilders would make no guarantee, has ordered two ships built with the turbine engines. The Cunard line deserves great praise for its grit in thus taking up the advanced idea. The navy will make a practical experiment shortly. Three scout ships are to be built. One will have the reciprocating engines now in use, while the other two will be equipped with turbines, one of the Parsons-Westinghouse type and one of the Curtis model.

"I left here January 26 on the Kaiser Wilhelm II, and disembarked at Plymouth. In London I had repeated interviews with Lord Selborne, First Lord of the Admiralty; with Rear-Admiral Sir John Durstan, Admiral May, Admiral Oram and Sir William H. White, former naval architect, and with the members of the Cunard line commission that was appointed to study the turbine. The English admirals gave me much information, and were much more liberal than the Cunard commission, which I found was pledged to secrecy. I went to the Clyde, to Belfast, and to several other shipbuilding places in the United Kingdom where turbines were building.

"I found the whole of Europe alive to the problem of the new engines, although none were satisfied as to the claim of economy of coal and weight which is made for the turbine. There seemed to be no question as to the economy of space in the minds of the great engineers over there. All are anxious to build, none will guarantee anything. In my visits to foreign shipyards I went to Stettin, Hamburg, Flushing and through some French yards. I found the French yards dabbling in the turbine to a small extent only. Of all the engines that I examined I found the Westinghouse 'double flow' the best."

While the formal decision of the Navy Department as to where the two colliers authorized to be constructed by the Government are to be built will not be made until Paul Morton has qualified as Secretary of the Navy to succeed Mr. Moody, it has been practically determined that one of them shall be constructed in the Brooklyn Navy Yard and the other in the yard at Mare Island, Cal. This conclusion is the result of a careful investigation of conditions in the various yards recently undertaken by Admiral Capps, chief constructor of the navy, who has submitted a report stating that, with the sole exception of the navy yard at New York there is not a single navy yard, either on the Atlantic or on the Pacific Coast, which is at the present time equipped with a building slip and overhead crane

facilities necessary for undertaking the building of a collier of the size specified in the naval appropriation act, inasmuch as this vessel will require a building slip as long and as fully equipped as that necessary for the Connecticut; that while the navy yards at Portsmouth, Boston, League Island, Norfolk and Mare Island are fairly well equipped with all usual shipbuilding tools, there are deficiencies in other respects, and the large improvements in progress at those stations, in docks, shops and other buildings, will render the undertaking of extensive shipbuilding work at this particular time less economical than would otherwise be possible.

AN APPROPRIATION NECESSARY.—The latest advices received by the Department indicate that the Connecticut will be launched next September, which will clear the building slip at the Brooklyn yard for one of the colliers by the time the plans and specifications have been completely worked out. The construction of the second collier, however, will be delayed until Congress can provide an appropriation for refitting the Mare Island yard. An urgent request will be forwarded to both Houses as soon as the new session begins and the necessary funds will doubtless be provided in the annual urgent deficiency bill, which this year will probably become a law before the holiday recess. With all possible expedition, however, several months will probably elapse after the first collier is begun before work on the second can be commenced.

The Bureau of Construction and Repair has completed a tentative design for the colliers as the basis for the calculations of the Bureau of Steam Engineering for motive power, auxiliaries, &c. The vessels will be of 12,500 tons displacement, with a length of 450 feet and designed for a maximum cruising speed of 16 knots. The engines will be of 7500 or 8000 horsepower, and each vessel will carry 5000 tons cargo of coal. The motive power and equipment will be quite similar to that of the refitted merchant ship Prairie, but the expense of installation will be somewhat reduced by the use of cast iron frames instead of cast steel. Twin screws will be employed.

It was the original intention of the Bureau of Steam Engineering to install Scotch boilers on the colliers, but calculations demonstrate that the space and weight of this type would render it impractical in view of the bulky cargo and the unusually large bunker space necessary to give the vessels the required steaming radius. A water tube boiler will be specified, but the exact type has not yet been determined. It is probable that some novel auxiliaries will be installed, in the shape of steam winches and other devices for getting up the cargo as rapidly as possible, and investigations are being made of a number of appliances designed for coaling at sea, in the hope that a thoroughly practical system can be provided. W. L. C.

—*Iron Age.*

ORDNANCE AND GUNNERY.

EXPLOSION ON BOARD THE FORBIN.—A 138-mm. (5.4-inch) cartridge exploded while some men were engaged in stowing ammunition away in one of the magazines on board the Forbin, while on passage from Rochefort to Brest, luckily failing to ignite the other cartridges near, but burning five seamen and causing some structural damage to the ship. The explosion is said to be due to decomposition of the powder under the action of excessive heat, presumably caused by want of ventilation and proximity to the boilers and stokehold. A curious result followed the explosion, which might have had serious effects. Several seamen, who sleep in the battery deck near the communication tube leading down to the magazine in question, were found during the night half asphyxiated in their hammocks from the effect of the noxious gases released by

the explosion of the cartridge. The ship since her arrival at Brest has been thoroughly fumigated, the men being sent to sleep on board other ships of the squadron.

The Admiralty has decided, after an extended series of trials, to adopt for naval requirements a new quick-firing gun. This will fire a projectile weighing 3 lbs. It is much more powerful than that firing a similar projectile already in use, and is to the design of Vickers, Sons & Maxim. The cartridge will be charged with modified cordite, while the gun, which is capable of exceptionally rapid-aim fire, will be fitted with automatic sights.—*United Service Gazette.*

PRIZE FIRING, 1903.—From the official returns of prize firing in the navy, it will be found that the shooting for the year 1903 has sensibly improved. Of this fact we have already been assured by Lord Selborne in the explanatory statement on the estimates. It is difficult to compare the results of 1903 with those of previous years, since a new method of tabulation has been adopted. The returns, as presented to Parliament, do not give the number of rounds fired, nor state the proportion of hits to misses. Instead of this, the following method has been adopted: The ships, divided into three classes, are shown in order of merit. The name of the best shot is printed, and also his score. Further, the returns indicate the "points" per type of guns and the total points achieved by each ship. This method of comparison is perfectly intelligible, and gives the public all the information necessary. True, it will no longer be open to captious critics to glance at the returns and record off-hand the precise proportion of hits or misses. But it will suffice for the public to know, for example, that the Majestic obtained 80 points out of a possible 100, the Benbow 11.65, and so forth. Speed of fire is considered in adjudging the points, and it is also possible that the type of gun mounting is allowed for. After all, the direct hit is a somewhat rough and ready test, if applied universally both to modern and obsolescent types of guns and mountings. Without arguing that the gunners of the Benbow and Sans Pareil can be wholly pardoned for having failed to hit the target with their 16.25-inch guns, it would be obviously unfair to expect as good a standard of shooting with these weapons as with the modern 12-inch guns mounted in our newest battleships.

The thirty-two battleships that competed, firing from 469 heavy guns, made the creditable average of 51.45 points. Roughly speaking, this may be taken to mean that about every other shot was a direct hit. The scores were, as usual, very unequal. At the head of the list is the Majestic (Lord C. Beresford's flagship), with her fine total of 80.49 points, and next to her the Albion (China), with 79.56 points. The Goliath is third ship with 77.63, and the Glory fourth with 72.75 points. These results are brilliant, and although poor scores were made in some cases, the general average of the battleships will be regarded as satisfactory. Also there is a general improvement, and that is sufficient proof that more attention is now being paid to gunnery training. The China battle fleet made the high average of 73 points; next came the Channel ships with 59 points; then the battleships of the Mediterranean fleet with 50 points, and, lastly, those of the Home fleet with the much lower average of 30 points. The relative inefficiency of the Home fleet demands explanation; but it must be remembered that the guns and mountings are not of the latest types. This consideration will weigh with experts, although the public has a right to expect that indifferent shooting (from whatever cause) shall be improved. We note that few of the battleships mounting 13.5-inch guns achieved high scores, that of the Anson being conspicuously low. The best battleship in the Mediterranean was the Bulwark, with 68 points, and next to her the Renown, with 62.35 points.

The average of the first and second-class cruisers was 51.63 points, or nearly the same as the average of the battleships. This is not quite satisfactory, as most of our cruisers carry a preponderance of 6-inch guns, and the high rate of fire from these weapons should give cruisers an advantage over battleships. Against this one must weigh the great improvement that has been achieved in the shooting of the 12-inch and other heavy guns, so that we ought not to look for a much higher average in cruisers than in smart battleships. At the head of the cruisers stands the Good Hope (Captain Madden), with the splendid total of 97.26 points. Next comes the Charbydis with 87.11, and four others, the Flora, Cambrian, Ariadne and Fox, made over 80 points. As usual, the cruiser scores vary very significantly, and one regrets to find the flagship of the Australian squadron so near the bottom of the list with only 23.82 points. The worst ship of this class was the Rainbow, with 11.71 points. With one exception, the new armored cruisers made good shooting, and the efficiency of this class is highly important. In the third category we find third-class cruisers, sloops and gunboats to the number of seventy-six. The average for this class was only 33.95 points, and the shooting in several vessels was distinctly bad. Thus we find the gunboat Bramble (China) making the high total of 87.14 points with her quick-firers, whilst the Speedy and Skipjack, of similar armament, are bracketed together at the bottom of the fleet with only 4.25 points! These variations indicate clearly the need for greater effort in certain ships. It is fair to consider, however, that in small crews it may be quite possible to have few first-rate marksmen. If our officers can succeed in raising the averages of the small craft, future returns will be more satisfactory. Meanwhile, the shooting from our battleships and larger cruisers is creditable, and whilst there is still plenty of room for improvement, the British navy may be proud of its gunnery progress during 1903.—*Army and Navy Gazette.*

RUSSIAN NAVAL GUNS.—Russian guns—the more modern ones, at any rate, which are practically Schneider-Canets—have, like the Belleville boiler and several other products of French genius, the reputation of being "very complicated." This is the verdict usually passed upon them by those whose technical acquaintance with artillery is confined to other types. Like the Belleville, their "complications" upon closer acquaintance turn out to be the result of practical experience, and they are complicated only because novel. Actually, Russian guns are simple enough to work, and the only thing about them puzzling to those of other nationalities is the duplication of safety devices specially provided for sailors whose general average of intelligence is below that of the men of most other nations. In this thing alone do the newer Obuchoff models differ from the French Schneider-Canet pieces on which they are modeled.

The result is some slowing of fire, because before the gun can be discharged, at least two, and occasionally three, safety devices have to be loosed. This is essentially a drawback, regarding the guns as guns, but by no means so when the Russian bluejacket is taken into account. One man is usually detailed to release these safety devices; if he fails, the gun cannot be fired, as there is no contact. All chance of firing with the breech improperly closed is, therefore, avoided by human instead of automatic mechanism. As a Russian sailor is normally liable to be somewhat erratic, there is no question of the advantages secured.

The standard guns in the Russian fleet are as follows:

The 12-inch of 40 calibers; weight, 59 tons; muzzle velocity, 2500 foot-seconds; muzzle energy, 32,000 foot-tons. This piece has a nominal penetration of 15½ inches Krupp cemented at 3000 yards with capped A. P. shell, the same as that of the United States Mark III. 10-inch, built for the Washington class. It is mounted in the Retvizan and Czarevitch. For the Borodino class, a 64-ton 12-inch gun has been designed, but it is

doubtful whether it exists as yet. It has the same velocity (service), but fires a 1200-lb. projectile instead of a 732-lb. one, and it has a correspondingly increased energy. The nominal velocity is 3000 foot-seconds. The Poltava class, the Sissoi Veliky, and all other battleships carrying 12-inch guns, down to and including the Sinope, carry a 35-caliber 12-inch gun. Its weight is 56 tons, its initial velocity 1942 foot-seconds (service), energy 19,200 foot-tons, shell 732 lbs. It is, of course, an old-type gun. Its penetration is for a 12-inch gun very small. The velocity is poor, and the piece is considerably inferior to the Japanese 12-inch gun. The rate of fire of this piece is slow.

A more powerful piece and a better gun is the 10-inch of 45 calibers, carried by the Peresviet class and the Apraksin and Rostislav. Its ballistics are inferior to those of the United States 10-inch Mark III., but it is superior to the Iowa's gun, being able to penetrate 13-inch Krupp armor at 3000 yards. As a gun, it is the finest heavy piece in the Russian service, and its rate of fire and accuracy are both good. It was seriously contemplated a few years since to have this piece only, its results being so superior to those of the 12-inch 35-caliber gun. It weighs 38 tons, and has a velocity of 2500 foot-seconds at the muzzle. It keeps up the velocity well; but the exact weight of the projectile is not known. It is somewhere about 500 pounds. Velocities of, or over, 3000 foot-seconds have been accredited to it; but these are merely trial results. Its defect is that the penetration is poor at long ranges, where the velocity drops, and the relatively light projectile tells against it.

The Gromoboi and Bayan carry a 45-caliber rapid-fire 8-inch gun. Its mechanism is somewhat tardy, and the rate of fire only about once a minute; but the gun is excellently constructed, and has very fine ballistics. It weighs 20 tons, fires a 250-lb. projectile, and has velocities up to 3000 foot-seconds, though the service velocity is lower than this. Its service penetration is about 8 to 9 inches of Krupp armor at 3000 yards. The new 7-inch is the United States gun it most nearly resembles in power; but its energy is better on account of the heavier projectile.

The 6-inch rapid-fire is of 45 calibers, and fires shell of both 111 and 88 lbs. weight. The service velocity is 2460 foot-seconds, and the weight of the gun about 7 tons. It is nominally equal to 6 inches of Krupp armor at 3000 yards. Its rate of fire is moderate. In the latest ships it is mounted in a completely circular shield inside the casemate. The Czarevitch carries this gun on a twin mounting, as do the Poltava class. This mounting has given very satisfactory results as such mountings go. They always leave something to be desired. The 4.7-inch is a piece of 45 calibers about on a par with corresponding pieces in other navies.

All these guns have the Schneider-Canet breech mechanism, which is not equal to the Welin for rapidity, though less liable to derangement. A Russian innovation is a carrier below the breech-block, so that when the latter is opened, its weight is not thrown on the hinges. The mounting details and rifling follow the Canet system.

Most Russian ships have electric hoists. Their guns all use nitrocellulose smokeless powder. The projectiles are capped armor-piercing shell and common shell. No solid shot is used, as the Russians claim to find their capped armor-piercing shell equally penetrative. High explosives are not yet introduced. Fuses are the weak point in Russian gunnery.

Newspaper reports have made the aiming very bad; but enough account was not taken of the range at Port Arthur. There are same very good shots in the Russian fleet, and the average gunnery officer is efficient. He is able, and often acts as captain of a gun, as do other officers. Where the Russian fleet came to grief was in the fact that gunnery was totally neglected by Admiral Stark, who devoted his time to battle evolutions of the parade-ground type.

In conclusion, mention may be made of a few other guns in the Russian service. A 9-inch piece exists in some small coast defenders and armored

gunboats. It is an obsolete gun, of which little is known and still less is worth knowing. There is also an old 8-inch in the Rossia and Rurik. It is 35 calibers long, and its highest velocity is 1922 foot-seconds. Its penetration is poor and its firing slow—it is less penetrative, in fire, than modern 6-inch guns.—*Scientific American.*

ANTI-TORPEDO-BOAT FIRE.

(An Extract from the Gold Medal Prize Essay of the Royal United Service Institution for the year 1904.)

Under this heading we will consider the anti-torpedo armament of a large vessel, and its capacity to resist torpedo-boat attack. This is a side issue of Blockade Strategy, because a blockading fleet will be particularly liable to torpedo attack, and *the danger of the torpedo-boats will often exercise a potent influence in shaping a strategical plan.* At night, firing at a target (20 feet long by 7½ feet high) with small Q.F. guns, the number of hits is seldom more than 3 per cent; on one occasion, when the shooting was average, there were 128 shots fired by all 12-pounder guns, and 6 hits on the target. On another occasion there were 4 hits; this is at a stationary target, *after the whole armament of sixteen 12-pounders* have been firing at an average distance of 800 yards. In an actual attack, the target would be moving 20 knots, the maximum *number of 12-pounder guns firing would be 8,* and the distance from 2000 to 800 yards. If a good watch is being kept, a torpedo-boat may be sighted 2000 yards (1 mile) off on an average night.

From 2000 yards the change of distance and the period under fire is as follows:

Speed of battleship, 12 knots.
Torpedo range at night, 600 yards.
a = Change of distance per minute in yards.
b = Gun-fire period.

Bearing of Torpedo-Boat.	Speed 18 knots.		Speed 20 knots.		Speed 22 knots.	
	a.	*b.*	*a.*	*b.*	*a.*	*b.*
Ahead	1,000	1m. 24s.	1,066	1m. 18s.	1,133	1m. 13s.
2 points on Bow	960	1m. 27s.	1,040	1m. 20s.	1,100	1m. 18s.
4 points on Bow	925	1m. 31s.	980	1m. 28s.	1,050	1m. 19s.
6 points on Bow	850	1m. 33s.	900	1m. 33s.	950	1m. 28s.
Abeam	720	1m. 56s.	795	1m. 45s.	855	1m. 34s.

It will be seen that 2 minutes is too great an estimate for *the under gun-fire period, which is nearer one minute than two.*

Consider, now, the anti-torpedo-boat guns of a modern vessel.

These may be divided into:

Boat-stopping shot—6-inch, 12-pounder, 3-pounder.

Man-killing shot—3-pounder, 1-pounder, Pom-pom, Maxim.

One 6-inch shell will sink a boat.

One 12-pounder shell bursting in fore compartment will blow a hole in the boat and disable her.

A 3-pounder shell may cut a steam pipe or disable the steering gear, but cannot be depended on to stop a boat.

Apart from any actual damage done, a heavy fire will disconcert the torpedo-boat crew, and tend to hurry and inaccuracy.

The anti-torpedo-boat guns, or guns which can be used against torpedo-boats, carried by modern vessels are:

Gun.	Size.	Projectile.	Rounds per min.
		lbs.	
16-cm.	6.4-inch.	100	3
6-inch.		100	4
14-cm.	5.5-inch.	60	5
4.7-inch		45	5
10-cm.	3.9-inch.	31	6
9-cm.	3.5-inch.	17½	6
14-pounder	3-inch.	14	6
12-pounder	3.4-inch.	12	6
6-pounder	2.2-inch.	6	10
3-pounder	1.8-inch (47-mm.)	3	10
1-pounder, revolver	1.4-inch (37-mm.)	1	50
1-pounder, automatic	1.4-inch pom-pom.	1	100

The anti-torpedo-boat armament carried by the latest battleships of different nations, at sea, or nearly complete, is as follows:

England.	France.	Russia.	United States.
(Twelve 6-inch.) Sixteen 12-pdrs. Six 3-pdrs.	(Ten 6.4-inch.) Eight 3.9-inch. Thirty 3-pdrs.	(Twelve 6-inch.) Twenty 12-pdrs. Twenty 3-pdrs. Eight 1 pdrs.	(Twelve 6-inch.) Twelve 14-pdrs. Twelve 3-pdrs. Four 1-pdrs. Four 1-pdrs., automatic.
No. of shots per minute on one broadside } 102	130	378	420

Guns above 4-inch cannot be correctly described as anti-torpedo-boat guns, but it would be a mistake not to use them. Every possible gun should be brought to bear. The 6-inch guns of one broadside can emit 36 shells in a fire period of 1½ minutes, and one of these hitting a torpedo-boat would sink her.

The points to be attended to are:

1. See all ready before sunset.
2. W. T. D.'s all properly closed.
3. No lights showing outside the ship.
4. Picked shots by the guns.
5. Good fire system.

W. T. D.'s are usually not thought of. Point 4 is absolutely neglected. When the watch mans and arms ship, captains of parts tell off hands to their guns, *quite irrespective of their marksmanship.* At some of the guns you will find an ordinary seaman and a boy, whose knowledge of the gun is practically *nil. The point that officers fail to grasp is the shortness of the fire period.* The men who are lying at the guns will be the only ones to take part in the attack; *in a fire period of one minute there is no time for hands to man and arm ship,* for the commander to be called, etc. The safety of the ship will lie in *one heavy burst of firing.*

Nets are not much good at sea when the ship is moving, and in modern battleships the lower booms have to be got out first in order to haul the torpedo booms clear of the ship's side, which is clumsy, to say the least of it. With everything ready on an evolution morning in harbor, nets are got out in about 2½ minutes. At 1 a. m. at sea, to clear away the nets, get the lower booms out and haul forward would take nearly 15 minutes, and if the ship cruises with nets out, all the advantage to be gained from speed is lost. The use of nets is limited to harbor; general opinion is against their use at sea.

A good and simple fire system is a very important adjunct of torpedo-

boat defense. The time is so short and the distance changes so rapidly that it would be impracticable to pass the range and alter the sights.

The "Same distance" method of fire control is possible. Sights of all guns are set at the same commencing distance, say 1000 yards; the general fire effect is noted by a competent observer; fire is stopped by bugle for a few seconds; the order is passed to raise or lower, and fire commenced again.

This method, however, is not altogether suitable for anti-torpedo-boat fire at night, because:

1. *Every second is valuable.* While stopping the fire and passing the word several seconds run out.
2. *Time is too short* and the pressure too great to raise or lower the sights amounts as specified by order.

METHOD PROPOSED.

The method proposed may be designated as *fire zoning,* and consists in *keeping a zone in front of the boat swept by fire,* through which the boat must pass. As many guns as possible *are equally distributed over the overlapping dangerous spaces of the fire zone.* The method is based on two assumptions:

a. Guns should be set at different distances.

b. Sights can only be altered once. Thus fire is commenced with a certain distance (*commencing distance*) on the sight, and after that jammed down to a second prearranged distance (*final distance*).

The arrangement of the anti-torpedo armament requires consideration. At present our boat decks and shelter decks upon the bridges, which are the ideal position for anti-torpedo guns, are blocked up, and *their view obscured by boats and peace bridge stanchions.* Enormous boats are carried, which effectually prevent vision signals between the conning towers and casemate hoods. The conning tower is not only useless for conning the ship, but is covered with a heavy bridge and houses, which would come down over it like a candle extinguisher. These matters may be seen far afield from strategy; but great weights may hang on small wires. Torpedo-boat smashing is *an important matter in Blockade Strategy,* and it is dependent to a great extent on the position of the anti-torpedo guns. The first requisite is that the field of view should be as open as possible. Anti-torpedo-boat guns should not be placed in ports. The 12-pounder guns on the main deck never made good night shooting. A suitable armament would be:

Guns.	Number.
12-pounder	16
3-pounder	10
1-pounder (automatic)	10

Arranged as follows:

ANTI-TORPEDO-BOAT GUNS.

Position.	12-pounder.	3-pounder.	1-pounder.
Fore Shelter Deck	2	2	2
Boat Deck	4	4	2
Upper Deck	8	—	—
After Shelter Deck	2	2	2
Fore Top	—	1	2
Main Top	—	1	2

NUMBER ON A BROADSIDE.

No.	Guns.	Shots per minute.
6	6-inch	24
8	12-pounder	48
6	3-pounder	60
5	1-pounder (auto)	500
		Shots per minute 632

The 1-pounder automatic is a useful gun, as when the fire period is very short everything depends on compressing as much fire into the time as possible. Weight and number must be combined; and the *disconcerting effect alone of five 1-pounders firing 100 rounds per minute would be very valuable.—United Service Institution.*

CHANGES IN CRUISER ARMAMENTS.—Comparatively full details of the armament changes in some of our new cruisers are now available, and some comment upon them seems desirable. The most important change—a revolutionary change, in fine, is in the Warrior class, the later sisters of the Duke of Edinburgh and Black Prince. These vessels are stated to have been too far advanced for the change to be desirable. In the Warrior's it will be effected, and it is so drastic that they will form a class quite distinct from the Duke of Edinburgh. Originally they were designed to carry ten 6-inch guns on the main deck battery at some 14 feet above the water line. Now the 6-inch guns all disappear, and their places will be taken by four 7.5-inch ones, which, however, will be mounted on the upper deck between the amidship 9.2-inch turrets. This gives a height of some 22 feet above the water line. And this, in turn, entails increased command, range and ability to fight in all weathers. In the Drake's the main deck guns can hardly be fought in much of a sea way—a defect shared by the Duncan's to some extent.

In taking to guns all high up the Admiralty are imitating the French; though the latest French vessels carry the guns still higher, that is to say, at 28 feet or so above water. Of the virtues of this system no doubts can be entertained. But doubts do arise concerning the relative seriousness of the compensating defect. This is heavy rolling.

Long as the Warrior's are, they certainly seem likely to roll with four 9.2-inch, four 7.5-inch and the necessary armor protection carried at a level where, till the King Edward's, only four 6-inch and some 12-pounders were mounted. Presumably this has been carefully considered; but it will do no harm to remember that the Germans, who were badly bitten with the "high-platform" ideal some years ago, have for a good while now been lowering their platforms to our old practice. No modern German ship carries her guns appreciably higher than any of Sir William White's designs that ante-date the King Edward, and even this ship carries the more considerable portion of her guns on the main deck. The Warrior, therefore, is certainly a revolution compared even to the King Edward; and it is seriously to be hoped that plenty of experiments have preceded the new system that she marks. It was a saying of the late Admiral Makaroff, who knew more than most men in such matters, that a moderate conservatism was the greatest thing in naval construction, since no new departure could be fully adopted with safety till it had been exhaustively experimented with in practice. If adopted too quickly, failures were likely to result, and those who "went slow" then reaped the benefit. We do not say this with a view to discrediting the new ideal, but we do mention it with a view to enforcing the need of careful experiment. The reconstructed Royal Sovereign's—which are now far less excellent sea boats than they were before reconstruction—are a standing lesson as to the disadvantages attending the adding of weights high up. In these

an odd hundred tons has made a vast difference; in the Warrior's something like an extra 400 tons will be placed on the upper deck, which was never designed to carry it. Mr. Watt is a very clever naval architect, but we should feel more comfortable were we assured that the change is made with his full approval, and not forced upon him by the current thirst for high gun platforms.

There is a further question as to whether a broadside of two 7.5-inch guns is better value than one of five 6-inch. Were penetration the only factor, the two would be better, but other questions enter. There is shell fire. In a minute in action the five 6-inch guns would get off, say, at least twenty shells, where the 7.5-inch guns would discharge about five. Each 7.5-inch would be doubly as effective if it hit, but this only works out to a ratio of ten to twenty. If penetration and range are governing factors, then a single 9.2-inch gun extra per side would be preferable to the pair of 7.5-inch. Taking one thing with another, this, in our opinion, would be the ideal change, as a cruiser, with five 9.2-inch guns on the broadside, would be a terrific antagonist to any vessel of her class existing. There is no question whatever but that the 9.2-inch gun would be badly felt wherever it hit, more badly, we are sure, than the pair of 7.5-inch, which have very considerably lesser penetration. The weight, with mountings and protection, would be approximately the same. There would be the additional advantage of a simplified ammunition supply. But, of course, the problem that we have already referred to—that of the heavy weight of artillery on the upper deck—would remain.

In the Devonshire class, the two forward double-story casemates are to be abolished, and two 7.5-inch guns, carried on the upper deck, substituted for four 6-inch guns. Again, the question of seaworthiness must enter, especially as the County class ships all leave something to be desired in this direction. Again, too, we are of opinion that if any 6-inch guns are to go, the whole lot would be better dispensed with; and probably the Devonshire's could carry eight 7.5-inch guns—that is, a broadside of five 7.5-inch guns. The actual broadside will be three 7.5-inch and three 6-inch, which, if better than four 7.5-inch, is certainly not equal to five such guns.

To the County class nothing is to be done. This is unfortunate, since the naval officer with faith in the twin 6-inch guns of these vessels has yet to be found. For these, twin mounting single 7.5-inch should certainly be substituted.

It is worthy of note, by the way, that the once complained of "wetness" of the County class has been greatly modified of late. The cause was simple enough—the shape of an ash shoot! By giving this a triangular instead of a rectangular form, the ships have been made into very passable sea boats. This matter demands considerable attention, for it shows how very easily a ship may get a reputation for unseaworthiness that she does not deserve. Possibly some little thing of the same sort may account for the alleged "wetness" of the Duncan's.

There is reason to think that in the abolition of forward casemates in the Devonshire's, the Admiralty have had in mind the bad reports received about low sponsons, which make the ships unnecessarily wet, and can with difficulty be fought in anything of a sea way. It is to be noted that in the Duke of Edinburgh there will be no sponsons, and, so we understand, no attempt at head fire from the main deck guns. On paper this looks bad, but in practice advantage is likely to result.—*Engineer.*

REPORT ON NAVAL ORDNANCE.—The annual report of the Navy Bureau of Ordnance is the valedictory as Chief of Bureau of Rear-Admiral O'Neil, who vacated his appointment last month, and he makes it the occasion for summing up his work during his period of service. When Admiral Ramsey was Chief of the Bureau of Navigation, he set his face against the continuous detail of navy officers on ordnance work. The result is

shown in a decrease of efficiency. Admiral O'Neil now reports that "after an experience of several years in charge of the Bureau of Ordnance, the Chief of Bureau is forced to the conclusion that the present method of performing important ordnance duty—that is, such as relates to the design and development of ordnance material—by the temporary detail of naval officers, is far from satisfactory. The officers are just as intelligent, and quite as efficient, as before, but they are not allowed time to study the complex problems of modern naval ordnance. The Chief says: "The Bureau is unable at the present moment to suggest a remedy for these conditions. It almost seems as if a permanent corps of specially trained officers to perform ordnance duty is necessary if we expect to do justice to this important branch of the service. It is no exaggeration to say that should one or two officers now on duty in the bureau be detached without proper reliefs—and proper reliefs are very hard to find—the most important duties of the bureau would practically come to a standstill, and serious embarrassment would follow. Such a system, therefore, cannot be a good one. No private establishment would expect to maintain efficiency by changing its technical staff every year or two, and yet this is exactly what takes place in the Ordnance Department of the Navy."

The difficulty with turrets and gun emplacements, due to the great energy of the high-power guns, has been remedied, and no further difficulty is anticipated. At the gun factory, 150 new guns have been completed, and eleven 6-inch B. L. rifles converted into rapid-fire guns; 365 mounts have been manufactured, and 386 are under way. The factory is entirely inadequate to the work of supplying the new vessels with their armament, and contracts have been made with private establishments for part of the work. As it requires as much time to manufacture the armament of a battleship as to build the ship herself, it is contended that work on the armament should be commenced when the ship is begun. The bureau is not averse to giving out a portion of its work to private parties, but believes that the major portion of it should be done by the Government in its own shops, in order that it may exercise full control and supervision of the work, and because it can do it in a more satisfactory manner than anyone else; and, above all, because it is deemed advisable for the Government to be in a position to control, to a great extent, the manufacture of its naval ordnance. Some of the 12-inch guns of the Tennessee class are a year behind, the 7 and 8-inch guns of the Idaho class three years, and of the Louisiana class the same, while the 4, 5 and 6-inch guns of the Maryland, St. Louis, Paducah, Idaho and Tennessee classes are incomplete, some of them being from one to three years behind. The present output of 3-inch guns is about sixty a year. The productive capacity of the gun factory, working double time, or sixteen hours a day, is thus seen to be from 54 to 100 per cent short of the demands made upon it by the average yearly appropriation of Congress. Working eight hours a day, the above percentage would be nearly doubled, and working the full twenty-four hours per day, the capacity will still be from 20 to 25 per cent too small. There is a similar deficiency in the output of gun carriages.

The bureau, therefore, is of the opinion that the judicious course to pursue under the circumstances is to seek such aid as can be afforded by the Army gun factory at Watervliet, and to contract with private parties to such an extent as can be done with prudence, having due regard to the certainty of the completion of the work within the required time; getting as much work as practicable out of the naval gun factory by making such additions and improvements as are absolutely necessary at this time to enable it to maintain its maximum degree of efficiency and are most urgently required.

The only development of consequence during the past year in connection with torpedoes has been the preliminary test of a turbine-driven

torpedo. So far as the action of the turbine was concerned, little was left to be desired, and its strength, simplicity and durability commend it for use in place of the intricate and delicate engines and valve gearing heretofore used. It is the opinion of this bureau that the most effective use of torpedoes is most likely to be obtained when they are placed on vessels designed especially to use them, such as torpedo-boats and submarine boats. Their value on board large vessels is, to say the least, problematical. In war games an arbitrary and possibly a fictitious value is given to torpedoes, and vessels having them are rated as superior to those not having them. Other things being equal, there is no question but that the use of under-water torpedo-tubes introduces a very complex system. They take up a great deal of space, and are, with their auxiliaries, quite heavy.

As the chance of hitting in a straight run is greater, the adjustable gyroscope is not commended. The torpedo is essentially a weapon of opportunity, and probably of remote opportunity. No case is recorded of one vessel having torpedoed another, nor of the use of the automobile torpedo having affected any naval combat.

The submarine tried gives promise of usefulness within their proper sphere. With increased familiarity with them, the boats are more skillfully handled, and so far as known to the bureau they fulfill the conditions for which they were built, as far as can be determined, except in actual warfare. Their utility will, of course, depend largely upon the skill and nerve of their crews in time of war. The Protector, built by the Lake Torpedo Boat Company, gives promise of being a useful and practicable vessel. The naval magazine at Cavite is a menace to the neighborhood, and should be removed to a safer place. An appropriation should be made for the New England naval magazine. All target practice is to be conducted hereafter with service ammunition, in order that the gun pointers may become accustomed to firing under battle conditions, and that the ordnance outfit may be thoroughly tested at each practice. It is estimated that the cost of target practice per annum of all completed vessels will amount to $1,366,000, and when all the vessels now building are completed, to $2,690,000 per annum, exclusive of the cost of targets, etc., which is very considerable. The cost of recent target practice for certain vessels is as follows: Indiana, $43,780.82; Alabama, $53,989.16; Kearsarge, $37,621.46; Illinois, $45,486.62.

Practically all brown powder has been withdrawn from the allowance of ships, and what little remains in service afloat will soon be replaced with smokeless powder. The manufacture of smokeless powder during the past year has proceeded at a fair rate, about 900,000 pounds more having been delivered than during the preceding year. The stability of powder of recent manufacture is of the highest order, and need cause no concern in the future.

The manufacture of armor has progressed in a most satisfactory manner, showing a marked increase over the rate of delivery over the previous year. The use of capped projectiles in testing armor has resulted in an increase of its resistance to penetration. Satisfactory progress has been made in the manufacture of projectiles, and several large contracts have been given out.

It is proposed hereafter to supply telescopic sights, as well as open day and night sights, on both sides of all guns of and above 3 inches in caliber, when not mounted in turrets. Experiments are being made with telescopic sights attached to 6-pounder guns.

The condition of small arms continues unsatisfactory. It is again recommended that 15,000 guns be replaced by U. S. magazine rifles, caliber .30.

The importance of official inspection and test of ordnance material, such as the maintenance of guns and mounts, powder, projectiles and

armor, and the installation of the two first named by commissioned line officers of the Navy cannot be too forcibly emphasized.

Congress has dealt most liberally with the bureau. Since June, 1897, it has received appropriations to the extent of $66,000,000, and no question has ever arisen with the accounting officers of the Government or with the Department as to its disbursement.

The estimates for the coming fiscal year aggregate $16,053,933.39. Of this, twelve millions is for the increase of the Navy, $248,900 for public works, $250,000 for reserve guns, $60,000 for the naval militia, and the rest for general expenses.

The report closes with a word of special commendation for the present assistant chief of the bureau, Lieutenant Volney O. Chase, U. S.N., whose professional attainments, industry, good judgment and general efficiency have rendered him a most valuable assistant.—*United Service Institution.*

The French Northern Squadron recently engaged in target practice at Brest against three old torpedo-boats. These were moored in line ahead, and were supposed to represent a division issuing to attack. The ships engaged were in two divisions, the Masséna, Jauréguiberry, and Jeanne d'Arc, and the Bouvines, Tréhouart, and Henry IV, and the range was 4400 yards, closing to 2300 yards. The boats were badly damaged, and one nearly sank, but was towed by the Guichen into port. After this exercise the squadron left for Cherbourg.—*A. & N. Gazette.*

A new landing gun has recently been introduced into the Austrian navy. It is the product of the Skoda Works, Pilsen, and is entirely of Austrian manufacture, says the *Militar Wochenblatt.* It is a 2.6-inch gun of nickel steel, and is 18 calibers in length. The barrel recoils on the carriage, and its support moves on a pivot. The system of laying the gun is that of the Austrian field gun, and the elevation is effected by two concentric screws. The barrel weighs 282 lbs., the carraige 194 lbs., the brake 16.5 lbs., the axle 48.5 lbs., each wheel 55 lbs., gun and carriage 793.6 lbs., the limber with 48 rounds, consisting of 16 shells and 32 shrapnel, 970 lbs. The whole can be drawn by ten men. The weight of the projectile is 8.8 lbs., and the muzzle velocity 1050 feet.

The wonderful new Japanese mine, which is half a mine and half an automobile torpedo, may be taken *cum grano salis.* So far as we can gather, it is the 24-inch coast defence torpedo, which Japan has had for the last three or four years.

The 1902 model 12-inch, which the French are putting in the Republique class, will be considerably the most powerful gun afloat. The velocity is over 3000 foot-seconds. and its penetration with capped A. P. somewhere about 23 inches of K. C. armor, supposing such armor to exist. In other words, it will get through anything on ships built and building at almost any range. There are plenty of people who tend to write down the French fleet as of no great account, but these are they who fail to note that in everything pertaining to naval engineering progress France is well to the front. The guns which we are putting into our new ships are approximately equal to French models of the 1893-96 period. We arm our ships "from stock," the French arm them with the best guns to be had. There is only one nation behind us in this respect, and that is Germany, which, curiously enough, is the champion laggard. There is not a gun on the German fleet over 40 calibers in length, and penetration is feeble accordingly. Germany's 11-inch also is at the best far behind the 12-inch of all the other Powers, and her 6.7-inch is a very humble gun beside our 7.5-inch, and even more so behind the powerful French 7.6-inch, to say nothing of the American 8-inch.—*Engineer.*

The *Revue du Cercle Militaire* states that the Turkish Government has ordered seven torpedo-boats of Ansaldo-Armstrong, of Genoa. They are to be delivered within ten months, and to cost £224,000. Each boat is to have twin-propellers, engines of 2200 horsepower, and a speed of 24 knots.

Several orders have just been received by the Whitehead Torpedo Manufactory (Silurificio) at Fiume from different Governments. Russia has ordered one hundred, France one hundred and thirty, Austria one hundred and twenty, and Italy sixty, of the latest model, six meters and a half in length. These torpedoes have hitherto only been in the possession of the Japanese.—*U. S. Gazette.*

Important experiments in progress in connection with the Whitehead torpedo give promise of materially increasing its effectiveness by adding to its range. At present the larger size, 18 inches in diameter, is limited to 1000 yards, and although this may seem satisfactory, quick-firing guns make it dangerous for any light craft to come within close enough range to deliver an effective blow with a torpedo. Courage, darkness, and luck have done much in the Far East. The experiments now being made have proved that the 18-inch torpedo can be made to travel 3300 yards, and the United States authorities are going even further, as they have on order two torpedoes, 21 inches in diameter, to have a range of 4000 yards. These will practically double the destructive capacity of the existing weapons. It is contended, however, that progress is necessary in another direction—towards the provision of a light rapid-firing mechanism for discharging torpedoes of limited power and range, as this is regarded as probably the line on which submarine boats may be beaten. Their speed is limited so that longe range is not required. What is necessary rather is rapidity of fire and lightness, so that the gear can be carried by small craft. Naval experts are not much enamoured of the idea of sweeping waters where submarine boats are supposed to lurk. Should the submarine boat operate under the protection of larger ships or forts, such sweeping actions would be difficult, if not impossible; while the submarine could still do effective work unless attacked by quick-firing torpedo-equipped vessels.—*U. S. Gazette.*

In connection with the submarine manœuvers which are now taking place at Spithead, a new phase of experiment in torpedo and submarine warfare is being carried out. Hitherto submarines, convoyed by destroyers, have been pitted against large ships, and in the recent manœuvers the issue was a doubtful one, but it was understood that, given favorable conditions, the submarine was a powerful weapon against cruisers and battleships. In the present manœuvers submarines are fighting against destroyers, and no large craft are employed. The second division of the Portsmouth flotilla, composed of four 27-knot destroyers, represents the enemy, and three submarines are defending the approaches to Portsmouth Harbor. The operations, which only take place in the daytime, are to extend over about a week. The idea is to test the value of submarines for defending narrow waterways leading to harbors. A novel form of target practice was tested on Wednesday. Some canvas models of the top of submarines had been made, showing the conning tower awash. These were drawn at full speed past a destroyer, which fired into them at various distances with her 12-pounder guns, making a good many hits. The results of the manœuvres are to be treated as strictly confidential, but so far they are considered to have been in favor of the destroyers. It has been found that these vessels are more difficult to attack than large craft. Captain R. H. S. Bacon, commanding the submarine flotilla, is in charge of the operations.—*U. S. Gazette.*

MISCELLANEOUS.

CAPTAIN BAYLY'S REPORT ON THE BATTLE OF CHEMULPO.—In connection with the engagement between the Russian ships Variag and Korietz and the Japanese fleet, I beg to enclose the following remarks:

Chaplain Rondneff states that the carrying away of the wounded on stretchers became impossible; several men were carrying them when shot down, and only five men altogether were brought down to the doctor below the water line, while of these five the doctor of the Variag says two were practically dead when they arrived. They have held classes on board the Variag to instruct the men in "first aid"; bags of bandages had been served out, and the doctor says that some lives were thus saved by being thus treated. The Russian sailors bear their operations wonderfully well.

There were 150 men employed on the Variag's upper deck during the action, and nearly all the killed and wounded were out of this 150, which is, 28 per cent killed, 45 per cent wounded. It must not be forgotten that, having no gun shields, her guns' crews were practically unprotected, and that shrapnel shell were largely used, to judge by the holes in the boats, funnels, etc. All was quiet in the engine room, as though they had been at target practice. In one stokehold (they have five, with no fore and aft bulkhead) the water came up to the floor of the furnaces, but did not get into the other stokeholds. It is believed to have come through a hole made in Variag's water-line when she was inclined and traveling at a reduced speed while turning.

While suffering her severest punishment—*i. e.*, when she was turning, thus keeping the range constant and her speed reduced, she had only four guns (I am told by her commander, who is living with me) that were not temporarily disabled. One 12-pounder was knocked clean across the deck from port to starboard. One set of cartridges caught fire on deck and burned so rapidly that two men were burnt to death, the body of one falling down the ammunition hoist with the clothes on fire. There were five fires altogether, of which four were successfully combated by the fire mains, and the fifth (which was caused by a shell bursting in the flour-tank and which caused such a smoke that the scuttles had to be opened) would probably have been put out had not the ship sunk.

The range was taken by an officer on the forecastle and shown to the guns by an instrument in the top, but both men in the top were seriously wounded, one having his leg so nipped by a portion of the fractured steel of which the top is made that they had to cut some of the flesh of his leg away so as to extract him. The doctor was below the water-line; the gunnery, torpedo and navigating lieutenants, together with the helmsman and a man for working the engine-room telegraphs, were in the conning tower, the commander was running from place to place on the upper and main decks to stop fires, assist supply ammunition, etc. The captain stood near the entrance of the conning tower, and during the action, when his bugler and orderly who followed him about were on either side of him between the conning tower and its entrance screen, some pieces of a bursting shell arrived, killed the bugler and orderly and bruised the captain on the cheek.

None in the conning tower were hurt. Very few signal halyards were shot away; her fore topsail yard was shot in two, and her peak halyards were cut, bringing down one of her ensigns. The decks were wetted before going into action. All communications worked well, but after the steering gear was damaged the noise on deck was so great and the officers on deck were so deaf with the noise that the voice tube to the hand-wheel was of little service and the ship was steered with the propellers until out of action. The cause of the accident to the steering gear is very obscure, but the consensus of opinion is that the rods leading to the steering engine were shot through, all the connections, steam and

electric and hydraulic, being cut through at the same time. Being only one rod as far as the telemotor, that would easily be the case were they not duplicated. The boats were riddled with holes except a steam pinnace, which was hoisted to davits on the starboard side forward; she was practically untouched, and has since been salved by the Japanese.

A very great deal of shrapnel must have been fired at the Variag, judging by the round holes, and not much lyddite, for there seems to have been no inconvenience from poisonous gases. Much trouble has been caused to the wounded on account of the pieces of cloth that are constantly being extracted. Many men are wounded with punctures, holes about as large as the top of the little finger and from ¼ inch to ½ inch or 1 inch deep, but with no foreign substance, such as iron, etc., being present in the wound, and no sign of scorching round the mouth of the wound.—*United Service Gazette.*

We learn from Port Arthur that the cruiser Pallada was practically unhurt by the torpedoing. The torpedo hit her right amidships, but made only a small hole. It blew coal dust in a storm into one of the boiler rooms, and crumpled up the tubes in one boiler, causing, however, only a single tube to split. The water that followed put out the fires.—*Engineer.*

That well known French writer on naval subjects, M. P. Le Roll, has an excellent article in *Le Yacht* of February 27 on the employment of torpedoes in the Russo-Japanese war. A month, he says, has not yet elapsed since the commencement of the war, and the torpedo is already spoken of as an arm of offense, rather than of defense. The thick and thin partisans of the weapon will perhaps raise too loud a clamor. We, however, who appreciate its real value in bold and capable hands, but who know also its eccentricities and defects, shall not draw too hasty and absolute conclusions from recent events.

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The writer goes on to remark that the automobile torpedo has made great advances in recent years, and has derived fresh importance from the introduction of submarines. Still, he thinks, it is the gun which will be the deciding factor in naval warfare for some time to come, and that the submarine will continue to be hampered by its slow speed and restricted field of view.

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Of the Japanese torpedo craft, he says that their commanders showed admirable skill and courage, while as to the Russian boats, it is, he thinks, impossible to understand their inaction, and he attributes it to the facts that the Japanese assault was unexpected, and that the battleships of Japan took no part in the night attack.—*United Service Gazette.*

THE DESTRUCTION OF THE PETROPAVLOVSK.—Until further information is available it would be useless to consider at length the conditions which led to the destruction of the Russian battleship Petropavlovsk. We deplore the death of Admiral Makaroff—a man not less able as an engineer than as a sailor. To him, it will be remembered, is mainly due the construction of the ice-breaker Ermack. The lost ship was built in 1894. She had displacement of 11,000 tons, and carried 750 men. Her armament consisted of four 12-inch guns, twelve 6-inch guns and a minor armament. She was fitted with four torpedo tubes above water, and one bow and one stern tube. She attained 16.38 knots on her trials. In type she so closely resembled our own Royal Sovereign class, though smaller, that the circumstances of her loss possess extraordinary interest. The one fact which appears to be certainly known is that a hole being blown in her bottom she upset. This revives an old controversy which was at its height at the time Mr. Nathaniel Barnaby was chief constructor,

concerning the effect of a loss of displacement on the stability of a ship. It has been maintained, furthermore, that a longitudinal bulk is sure to cause disaster, one side of the ship being overloaded. W the breakdown occurred some years ago in the Atlantic liner City of P it was held to be a fortunate circumstance that the central bulkhead pierced. It would be a terrible fact if, notwithstanding that a war may have a margin of buoyancy of a couple of thousand tons, she sh be certain to turn over long before that margin is exhausted. The is far more prominent in some vessels than it is in others; and it w be pleasant to know that our own Royal Sovereign class are superi this respect to the Russian ship. It is, of course, very largely a ques of distribution of weights. Probably it is impossible to do more t reduce the risk, and we must make up our minds that warships may s before they sink. The present war may well be full of instruction, a the loss of the Petropavlovsk is full of unpleasant suggestion for the na architect.—*Engineer.*

In *Le Yacht* of April 23, M. P. Le Roll has an instructive artic the loss of the Russian battleship Petropavlovsk. Rejecting the vari other hypotheses which have been put forward in explanation of t disaster, the writer considers it beyond dispute that the Japanese, af carefully studying the passage by which the Russian ships were obser to leave and enter Port Arthur, took advantage of a more or less m night to send in torpedo craft and lay mines right in the fairway. Se mines requiring time to become operative, the Russian squadron pas out unharmed, but returning about ten o'clock on the morning of t 13th, two of the ships collided with the mines so laid, and explos followed.

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To account for the difference in the magnitude of the results experie in the cases of the Petropavlovsk and the Pobeida, M. Le Roll advan the following ingenious explanation. The Pobeida, he thinks, was pro ably struck amidships, where the armor would be thickest, and, mor over, the Pobeida being a newer vessel than the other, the system compartments into which she is divided would perhaps be more comple The Petropavlovsk, on the other hand, possessed armor only for two thirds of her length, the fore part of the ship being unprotected. It w here, he thinks, that the sunken mine took disastrous effect, and th equilibrium of the vessel was quickly destroyed. From the subsequ explosions, and from the fact that the few members of the crew sav were nearly all wounded, he draws the conclusion that the vessel w struck in the neighborhood of the magazine, which, being exploded, com pleted the destruction of the vessel, and he points to the case of th Maine, in which case also the magazine exploded, as confirming h opinion. "The Japanese," he writes, in conclusion, "have been equa successful with fixed mines and automobile torpedoes, and it cannot b denied that they have given proofs not only of courage and skill, but o considerable subtlety, and possibly their adversaries have not been suff ciently alive to this Oriental trait in their character."—*United Servi Gazette.*

A MARINE MONSTER.—The following account of a so-called sea serp observed off Haiphong by the gunboat Décidée is published in the *Trans*

In his official report, the commander of the Décidée states: "I ha observed the back of an animal about 300 meters (328 yards) off th port beam, having the form of a rounded black mass, which I took to b a rock, but on seeing it move I imagined to be an enormous turtl 4 or 5 meters (13 to 16 feet) in diameter. Shortly after I saw this mass lengthen out into the form of a serpent with vertical undulations, appar ently having a length of 30 meters (98 feet), and a width of about 4 to

meters (13 to 16 feet). Different members of the crew can confirm these details in the most circumstantial manner. The animal appeared a second time 150 meters (164 yards) nearer, and dived under the after part of the ship, when the doctor observed the skin to be black, mottled with yellowish markings, and absolutely smooth; no fins were noticed. The head seemed like that of a turtle, and furnished with scales, and with a width of about 80 centimeters (31 inches), and it spouted jets of vaporized water.

COMPARATIVE NAVAL STRENGTH.—The annual Parliamentary return showing the fleets of Great Britain, France, Russia, Germany, Italy, the United States of America and Japan has been issued. It distinguishes the vessels built and building, and gives the date of launch and displacement and armaments. In some explanatory notes it is pointed out that vessels still included in the official effective fighting strength of each navy are shown in the return, except where there is information to prove that vessels officially classed as effective are assigned to special and non-sea-going duties. The vessels are not transferred from the "Building" to the "Built" portion until they are are ready for commissioning. The return is corrected to March 31 last.

BUILT.

	G. Britain.	France.	Russia.	Germany.	Italy.	U. States.	Japan.
Battleships, 1st class	49	20	16	14	13	11	6
" 2nd class	4	9	4	4	—	1	1
" 3rd class	2	1	1	12	3	—	—
Coast Defense Vessels, Armed.	1	14	14	11	—	11	2
Cruisers, Armored	28	15	8	4	5	2	8
Cruisers, Protected:							
1st class	21	7	5	1	—	3	—
2nd class	*49	16	*3	8	5	15	12
3rd class	*32	17	2	13	†13	2	8
Cruisers, Unprotected	8	1	3	20	1	7	9
Torpedo Vessels	32	‡16	9	2	14	—	1
Torpedo Boat Destroyers	124	24	47	37	11	20	19
Torpedo Boats	87	233	107	80	108	31	82
Submarines	8	26	1	§1	1	8	—
	445	399	280	213	204	111	148

BUILDING.

Battleships, 1st class	10	6	9	6	5	11	2
To be laid down 1904-5	2	—	—	2	1	2	—
Cruisers, Armored	13	6	—	2	1	11	—
To be laid down 1904-5	4	3	—	1	—	—	—
Cruisers, Protected:							
1st class	—	—	3	—	—	—	—
2nd class	2	—	—	—	—	2	1
3rd class	4	—	2	4	—	—	—
To be laid down 1904-5	—	—	—	3	—	—	—
Scouts	8	—	—	—	—	—	—
Torpedo Boat Destroyers	22	9	14	—	2	—	1
To be laid down 1904-5	14	6	—	6	—	—	—
Torpedo-boats	4	20	—	—	8	1	3
To be laid down 1904-5	—	74	—	—	6	—	—
Submarines	11	14	‖14	—	3	—	—
To be laid down 1904-5	10	34	—	—	2	—	—
	104	172	42	24	28	27	7

* Including one partially protected.
† Including two partially protected.
‡ Including one torpedo depot ship. § Experimental.
‖ Not certain whether all these have been actually commenced.

Army and Navy Gazette.

There appears to be no real certainty as to the actual cause of the rapid sinking of the Petropavlovsk. Admiral Alexieff stated that the catastrophe was due to the ship having touched a Japanese mine, producing an explosion under the forecastle of the ship, as well as under the magazines, thereby, in the opinion of a special committee, which the Admiral shared, causing consecutive explosions owing to the combustion of pyroxyline in the torpedoes and the shells of the 12-inch guns. The explosion of the magazines and cylindrical boilers followed, the whole series of explosions lasting not more than two minutes. It is, of course, known that the Japanese had placed mines in this particular position, but there are still those who think that the catastrophe was due to an infernal machine. A naval engineer who served under the late Admiral Makaroff states that, in consultation with his officers, he had made all preparation to blow up the ship rather than to let her fall into the hands of the Japanese. With this view, electric wires passed to the magazine, and this authority says that the explosion was caused by the mine having completed the contact, thus bringing about the second explosion which actually caused the sinking of the ship. In regard to the mines, those Russian officers who have examined the locality discovered quite a series of them united together, and constituting a terrible means of destruction. It seems certain that the Japanese who laid these mines were well acquainted with the locality in which the Russian ships were accustomed to maneuver.—*Army and Navy Gazette.*

Further answering Mr. Yerburgh, Mr. Pretyman stated that on March 10, 1894, there were building in Great Britain 3 battleships, 5 cruisers, 2 sloops, 2 gunboats and 36 destroyers, while in Germany there were building on that date 6 battleships, 2 cruisers and 1 destroyer, a divisional boat of about 300 tons. On February 1, 1904, there were building in Great Britain 13 battleships, 22 cruisers, 2 sloops and 31 destroyers, while in Germany there were building 7 battleships, 7 cruisers, 1 gunboat and 6 destroyers. Mr. Pretyman, replying to Sir John Colomb, stated that the German program of 1900 allowed for two battleships each year from 1901 to 1909 inclusive. Up to the present this program had been adhered to, and had not been accelerated in any way.—*United Service Gazette.*

The number of battleships building and projected has lately formed the subject of several questions in Parliament, and also of some correspondence in the press. The position is unchanged since Lord Selborne's explanatory statement on the estimates, but Mr. Pretyman has furnished the following figures, showing the total tonnage of battleships building and projected: Great Britain, 187,000; Russia, 125,270; Germany, 103,976; United States, 209,180. It is further officially stated, as regards battleships projected, that the numbers are: Great Britain, two; United States, one; but that the Admiralty have no knowledge of the four Russian and two German ships alleged in some quarters to be projected. The numbers actually under construction are again given as: Great Britain, eight; Russia, nine; Germany, eight; and United States, thirteen. In this connection, Mr. Edmund Robertson, M. P., contributes an article to the *Nineteenth Century*, in which he argues that the two-Power standard has been exceeded by this country. To this article Lieutenant Carlyon Bellairs has retorted in a letter to the *Times* by giving recent foreign tabulations of relative strength in battleships. These tabulations, culled from the best sources, indicate that our numerical superiority in modern battleships hardly, if at all, exceeds the two-Power standard, and Lieutenant Bellairs argues that increased effort on the part of this country is warranted in the light of these figures and of foreign battleships projected. In effect, he also charges Mr. Robertson with an unfair application of tonnage figures in his article, observing that the economist is well aware that the standard only applies to battleships. This, indeed, has quite recently been

emphasized by Lord Selborne in the course of the speech delivered at Bath.—*Army and Navy Gazette.*

While we are looking askance at the great growth in our total naval vote, France regards with misgiving the increasing cost of warships, and some of the facts given may, in association with comparative figures for the ships of other countries, prove of considerable interest at the present moment. We readily admit the extreme difficulty of making comparisons between different types of ships; but if we take the rate per ton displacement there will be a fair approximation to accuracy—sufficient, at all events, for our purpose here. Nor need one go far back to indicate the increase; ten or twelve years will suffice. Our Royal Sovereigns of 1891-2 cost £67 10s. per ton; the King Edward VII of to-day cost £89 per ton. It is true that they are very different ships; but that applies to the vessels of all Powers, and it is still a case of merely counting units, so that the taxpayer has to pay for the same number of ships, although they are much superior. Thus the aggregate becomes much greater. In the case of the French ships there is an increase from the £93 4s. of the standard ship of 1891 to the £112 19s. per ton of the Patrie now being constructed. In the case of Russia the advance has been from £75 to practically £100 for the best of the vessels which have been put so unmistakably hors de combat in Port Arthur. The German naval authorities are paying £90 per ton, instead of £66 twelve years ago. The United States expect to pay for the new ships now being laid down £97 per ton. It will thus be seen that in nearly all cases the price of battleships has been in the period embraced increased from £22 to £25 per ton, or by about 30 per cent to 35 per cent. It will be noted, however, that the British ship of to-day is still of lowest cost.

Dealing now with armored cruisers, it is necessary to go back to the Australia class in the British fleet, as between 1886 and the Cressys of 1899 no such vessels were laid down. The Australias cost £60 per ton, while the vessels of the Duke of Edinburgh class of to-day, with their great gun power, work out to £83 10s. per ton. The French commenced the construction of the modern armored cruiser at a much earlier date than Great Britain. The Dupoy de Lome, launched in 1890, cost £55 per ton, while the Renan of to-day works out at £96. Russia paid more than £100 per ton for her latest armored cruisers in the Far East, as compared with £67 for those built twelve years ago and still in the Baltic fleet. The cost of the Kaiser's moderate-sized modern armored ships of the Deutschland class £96 12s., but there were no vessels twelve years ago with which comparison can be established. The United States are to pay £90 per ton for their new 14,500-ton cruisers. Here, again, Britain gets the best value for the money spent, and the increase, it will be noted, is greater than in the case of battleships, roughly between 40 and 50 per cent. The same holds good practically of every type of craft.—*United Service Gazette.*

Wireless telegraphy seems to be rendering good service in the Russo-Japanese war—at least for the purpose of transmitting news. The *London Times* has a dispatch boat fitted up for this purpose, by means of which messages are sent to Wei-Hai-Wei, and thence transmitted over the British cable. The *Times* recently published a message 1400 words in length, which had been sent in this way. This is probably the longest message that has ever been sent by wireless telegraphy, and seems to indicate that the installation is working most satisfactorily. The equipment on the boat has a capacity of from twenty to thirty words per minute, and the range is probably at least 100 miles, and greater under favorable conditions. Messages sent over this route have the advantage of not passing through the hands of either the Japanese or Russian censors, and therefore can be depended upon to contain all the news that the correspondent may be able to gather.—*Electrical Review.*

Some time ago an order was issued that the wireless telegraphy apparatus was to be landed from the battleships of the Mediterranean Fleet, except the flagships. This has now been done. No reason was assigned for the order, but it is generally understood that as the battleships cruise in company the apparatus is unnecessary, except in flagships. This decision is certainly open to question. The possibility of a battleship missing a rendezvous, or a small squadron being detailed for special service, seems not to have been considered. All cruisers on the station, however, retain their installations, and now a really serious attempt is being made to fit destroyers with effective and reliable instruments. Some years ago a trial of wireless apparatus was made in a destroyer, but it proved so unreliable, owing to vibration and other causes peculiar to destroyers, that the experiment was abandoned. It is left to private enterprise, skill, and ingenuity to perfect what the Admiralty abandoned as a hopeless task. Lieutenant Ryan, of the Panther, has for the last year or so conducted experiments in the destroyers which he has commanded, with relays and receivers of his own invention, specially constructed to overcome the vibration and other peculiarities of destroyers. He has been perfectly successful in sending and receiving messages with absolute reliability up to thirty and forty miles, with an aerial wire at the destroyer's masthead, and to more than double the distance when using a kite. The Admiralty have now granted a small sum of money to enable the experiments, or, rather, the system, to be extended (it has long since passed the experimental stage) to other destroyers. This success has more than doubled the value of destroyers as scouts, as it enables them to send the information they may gather in the same way as cruisers do, instead of using their limited coal supply in returning to the base.—*U. S. Gazette.*

ALLAN TURBINE STEAMERS.—With regard to the two new turbine boats which the Allan Company are building, the first of them, the Victorian, is to be ready for work in the summer of this year. The turbine machines to Mr. Parsons' designs are being constructed by Messrs. Workman, Clark & Co., Ltd., Belfast, who have secured the right of constructing such engines. The workmanship will be of the highest class, the boiler power ample, and the pumps, valves, condensers and other allied parts are specially adapted to the designs of Mr. Parsons. A special arrangement has been devised by Mr. Parsons, whereby a reversing power equal to that of the forward propelling power can be imparted to the machinery, securing almost instant arrestment of the ship's forward motion, and speedy backing in case of need. In this matter the Victorian is designed to surpass the ordinary steamer. The widespread arrangement of her propellers, of which there are three in number, each on a separate length of shafting, and the rapidity with which power can be directed upon each of the outer shafts separately, in any direction, will greatly assist the ship's maneuvering power. The Victorian will be by far the largest steamer and swiftest of the Allan fleet. She will be fitted in the best style for upwards of 1500 passengers, and is expected, by reason of the absence of vibration inseparable from the ordinary steam engine, and by the rapidity and unbroken steadiness of revolution in her shafting and propellers, to be both noiseless and steady in a seaway, even while steaming at full power. She is expected to save a day in the voyage between Liverpool and Montreal.—*Page's Magazine.*

TURBINE *v.* RECIPROCATING ENGINES.—The first of the vessels for the Midland Railway Company designed by Messrs. Biles, Bray and Co., has completed her specified trials, and the results attained indicate a high propulsive efficiency, which does the highest credit to the builders, Messrs. John Brown and Co., Limited, Clydebank. Their vessel, the Antrim, attained 21 knots on the measured mile and 20.6 knots on a six-hour run, and, in view of the conditions, this result establishes a high standard for

comparison with the sister ship Londonderry, having turbine machinery. A description of the Antrim appeared in our issue of March 25 (page 434). The trial was of six hours' duration, and commenced at noon on the 19th inst., by which time the guaranteed speed of 20 knots was reached. Four runs over the Skelmorlie measured mile were made betwen 12.15 p. m. and 1.30 p. m., giving a mean of means of exactly 21 knots. The vessel, after manœuvring for a time in the Firth of Clyde, was taken round Ailsa Craig, the trial finishing at 6 p. m., opposite the Cloch. Over the whole period the average speed was 20.6 knots. It should be noted that the vessel has two double-ended and one single-ended boiler; but, in accordance with the contract provisions, the latter was not in use throughout the trials.—*Engineering.*

The report by the hydrographer of the Admiralty of the work performed during the year 1903 in the examination and charting of seas and coasts in various parts of the globe has been issued as a Parliamentary paper. It appears that eleven vessels were regularly engaged in the operations, and that during the year 344 rocks and shoals which were dangerous to navigation were reported. Of these, 40 were reported by surveying vessels, 21 by other of his Majesty's ships, 12 by various British and foreign vessels, 13 were discovered by vessels striking on them, and 245 were reported by colonial and foreign governments.—*Scientific American.*

The *Neue Militarische Blatter* announces that the German Admiralty has been experimenting with the American Spencer-Miller apparatus for coaling ships at sea. The length of cable allows for a space of about 330 yards between the two ships, the weight of coal in transit at any one time being not quite ten tons. The diameter of the cable is a little over ¾ inch. In the experiments about 40 tons per hour were loaded, with the ships steaming at from five to eight knots. With some slight adaptations it is expected that 60 tons per hour will be reached. The objections to the apparatus are that it is of foreign make, and that the cost of a single installation is from £3000 to £5000. The apparatus is the same as that fitted to the new Russian warships.—*U. S. Gazette.*

At the Royal United Service Institution, on Wednesday, Mr. G. C. Mackrow, naval architect to the Thames Ironworks Shipbuilding Company, read a paper entitled "Coaling of Ships of War at Sea and in Harbor." Admiral Sir N. Bowden-Smith presided.

Mr. Mackrow, in the course of his paper, submitted a proposal for the coaling of warships at sea and in harbor which the Thames Ironworks had been working at for the past four years. They now submitted that they had arrived at a practical solution of the problem. The vital points, he said, were the hoisting and transferring of the bags of coal from the hoist on to a continuously running conveying line travelling at any speed up to 1000 feet per minute, and again upon reaching the battleship transferring the bags from the running line to the deck without in any way reducing its speed. The latter was a feat which they believed had never before been accomplished. These two points they had tested as far as possible on shore, and they could deliver from 50 to 200 tons with ease, and they would now be pleased if the Admiralty, before whom the invention had been for the past four years, would decide to give it a trial at sea. Rapidity, safety, and ability for the ships engaged in operations to proceed with the minimum diminution of speed were the three requirements necessary to any satisfactory solution. As to rapidity, they undertook to deliver from 50 to 100 tons per hour in a seaway in which the collier did not roll more than 15 degrees. With regard to safety, they believed they had fully provided against accident; and, with reference to the last requirement, they submitted that vessels could perform the operation equally well at high speed, at low speed, or at anchor. He then

described the gear, from which, he said, it would be seen that a continuous train of coal bags might be hoisted from the deck of the collier, transferred to the transporting line, and when arriving at the warship be again transferred by means of a shunt bar from the transporting line on to a carrier rail, and so arranged to travel to any point on the deck that might be desired near the coal shoots. The movement was continuous, so that no time was lost while the empty bags were being returned, as they were sent back on the inward running line, while the coals were being sent out to the warship by the outward running line. They had assumed that the coal could be brought to the head of the transporter at the same rate as it could be despatched to the warship. This at once raised the question as to the desirability or not of having specially built fast colliers, and it was the opinion of many naval officers, notably Lord Charles Beresford, that such vessels should be built to carry some 5000 tons of coal and capable of steaming 15 knots. The Thames Ironworks had got out a special design for a collier on the above lines. After describing the design, Mr. Mackrow remarked that the objection that might be raised to the proposal would be the cost of raising and maintaining such a fleet of colliers, as the special case they were proposing to meet was that of an emergency in war time. What they had thought would be a wise arrangement would be to subsidize a few fast steamers and fit them for the reception of one or two of their transporters. In peace time they had not to consider so seriously the question of the coaling of the warships; still, it might be considered advisable, he observed, to have a simple method of coaling even in port or harbor, and the Admiralty had been induced to give a trial to a proposal they had submitted for loading in harbor, which, in conclusion, the lecturer described. The proposal was to build a 1000-ton lighter, and at the end of each hold to fit one of their transporters, which would lift the coal, after being bagged, to any required height. The bag of coal, after reaching that height, was detached and allowed to slide down a shunt bar on to the deck of the gunboat or battleship. By this means, from the time the bag was filled in the hold of the lighter and hooked on to the over head travelling rail until it reached the deck of the battleship, it had not to be handled by anyone. *U. S. Gazette.*

CARE AND MANAGEMENT OF STORAGE BATTERIES.

BY EDWARD LYNDON.

(Reprinted from the *Electrical Review.*)

If the battery equipment of a station be given the same care and attendance as the generating machinery, and the same regard be paid to the battery, with respect to the service perfomed in relation to its capacity, no more trouble should be experienced with one than the other.

There is, however, a tendency on the part of some of the operators of battery equipments to let the part of the apparatus run itself until some condition arises which indicates that the battery is in trouble, and then attempts are made to rectify this trouble.

One characteristic of the storage battery, and perhaps an unfortunate one, is that it does not spark, run hot or loosen up joints when service other than the normal is called for. This is unfortunate in that it invites inattention and generally gets it.

Many of the alleged storage battery troubles would disappear if a regular and thorough system of records and inspection be adhered to.

The intention of this article is to outline the troubles to which batteries are subject and the methods of treating same, also to indicate the more important records which should be taken.

SULPHATATION.

The normal action of a storage battery on discharge is the formation of lead sulphate on both the positive and negative electrodes, and that of charge, the converting of this sulphate back to sponge lead on the negative and peroxide of lead on the positive electrodes.

The active masses of both plates are continually changing in volume with every charge and discharge, expanding on discharge and contracting on charge. The change in volume is more marked in the case of the negative material than with the positive, the negative active mass, Pb, absorbing twice as much oxygen as the positive, PbO_2, on discharge.

These changes in the sponge lead and lead peroxide to lead sulphate, $PbSO_4$, on discharge and the reduction of this sulphate to the original oxides of lead on charge, are accompanied by corresponding changes in the density of the electrolyte, increasing on charge and decreasing on discharge; this being due to the fact that SO_3 required for the formation of lead sulphate on discharge is taken from the electrolyte, decreasing its density, and on charge the SO_3 in this lead sulphate is given up to the electrolyte, increasing its density.

This formation of lead sulphate on discharge is perfectly normal and is not harmful unless an excessive amount is formed, and to so limit the amount formed on each discharge it is usual for the manufacturers to specify that discharge should be discontinued when the terminal electromotive force per cell has dropped to 1.8 volts, with normal rate of discharge flowing.

The ending of discharge at this point is not to be taken as an indication that all the active agents on both positive and negative plates have been converted into lead sulphate, but that the maximum amount has been formed that can easily and efficiently be converted back to the original substances on the passage of current in the opposite direction, that is, by charging.

If discharges be persisted in, in which greater amounts of sulphate have to be formed for the production of the current, the resulting excess sulphate will in time become harmful to a greater or less degree, as this sulphate will penetrate deeper and deeper into the body of the plate until it becomes practically impossible for the charging current to reduce this product of discharge.

When sulphatation has reached a certain degree it cannot be reduced by the passage of current, and if certain portions of a plate become sulphated to this extent, then these portions are simply inactive and perform no useful work, with the result that the capacity of such a plate is correspondingly reduced.

Lead sulphate in itself possesses no electrical conductivity and the production of this sulphate is accompanied by an increased internal resistance of the cell. Higher charging voltages are therefore required to force current through a sulphated battery than are necessary for cells in normal condition.

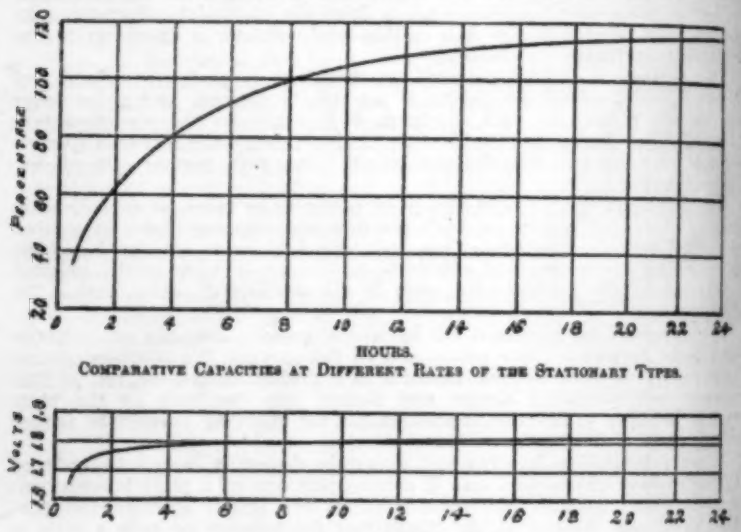
In fact, one good indication of sulphatation is the high-potential difference across cell terminals at the beginning of a charge, this high-potential difference being due to the drop caused by passage of current.

The effects of excessive sulphatation, then, are to increase the internal resistance and to cause the active agents to expand to a harmful degree, and this expansion on discharge with contraction on charge tends to separate the active agents from the supporting gird or frame, thus giving an additional increased resistance along the line of contact of the supporting element and its active mass, with a further tendency to decrease the capacity of the plate by isolating some of the active material to the extent that it becomes inactive.

The question of sulphatation and resulting change in volume of the active materials is one of degree, and the design of storage battery plates

is such as to allow for the limited expansion and contraction between normal discharge and charge with no resulting harmful effects, and the discharge should never be protracted to the point where the interior portions of the active masses are converted to sulphate.

The 1.8-volt point at which discharge is cut off holds only when this voltage per cell is in connection with some fixed rate of discharge, as the mere voltage taken without due consideration to the rate of discharge has absolutely no meaning, and when batteries are subject to rates greater or less than the normal eight-hour rate of discharge, the cut-off point, as determined by voltage, should be less or greater than the 1.8-volt point, and the proper point of cut-off may be determined by capacity and voltage curves for the particular type of cell used in the battery. Fig. 1 shows such a set of curves for a certain cell, the voltage curve shows directly the point of cut-off per cell for different rates of discharge, and from the capacity curve the ampere-hour output at any rate may be calculated.



COMPARATIVE CAPACITIES AT DIFFERENT RATES OF THE STATIONARY TYPES.

FIG. 1.—DISCHARGE RATES.

In the curve shown the ordinates represent percentages in ampere-hours, the capacity at the eight-hour rate being taken as 100 per cent, and the different ratios of discharge are shown on the horizontal scale, or if the cells corresponding to this curve be rated at 100 amperes for eight hours and the regular rate of discharge be for one hour, then, as shown by the curve, at this rate the ampere-hour output is fifty per cent of the capacity at the eight-hour rate, or 400 ampere-hours at the one-hour rate, giving 400 amperes for one hour, and the cut-off point being 1.74 volts, given by the voltage curve.

When batteries are to be worked at rates other than the normal the manufacturer should be consulted as to the proper point of cut-off.

Unless the proper point of cut-off be adhered to the continual formation of excess sulphate will finally reduce the capacity of the battery until it cannot perform its work. These are conditions of sulphate arising from overdischarge. The natural remedy for sulphatation is charge and plenty of it. The rate at which this charging should be done appears to

vary anywhere from one-half the eight-hour rate to the full five-hour rate, varying with different types of plates and in accordance with instructions from the manufacturers; in the former case the rate is increased as the charge continues, and in the latter the rate is reduced with continuation of charge.

In the case of badly sulphated cells, however, the temperature will usually limit the rate at which the charge can be introduced. On account of the increased plate resistance and that of the electrolyte, heat is developed on the passage of current and this current should be so regulated as to keep the temperature of the cell below 105 degrees Fahrenheit at all times.

Sulphatation manifests itself by high potential on the passage of charging current, low voltage on discharge, low density of the electrolyte, and, when it has proceeded very far, by the whitish color of the plates.

When sulphatation to a more or less degree extends over the battery as a whole, the cause for this will be over-discharge or under-charge, it being evident that the same effects may be produced, as far as the formation of sulphate is concerned, if the battery be under-charged.

If, however, this sulphate is confined to one or more cells composing the battery, the remaining cells being in a healthy condition, then some abnormal conditions must exist in the sulphated cells, sulphate being also a product of local action and short circuits, and these will be taken up under the heading of internal discharge.

Sulphatation of the negative will result if a charged negative be exposed to the air for any length of time and then replaced in the electrolyte, and if for any reason it becomes necessary to remove the plates from a cell while in a charged condition, the negatives should be placed in water or else the rapid oxidization of the sponge lead when exposed to the action of the air will develop considerable heat, and a negative in this condition when replaced in the electrolyte will be subject to local and chemical action with resulting sulphatation.

In the above it is not intended to imply that one or more under-charges or over-discharges will result in the formation of sulphate that will have lasting and harmful effects, for such is not the case. It is the continuation of such methods that will bring about disastrous results. At the same time, however, it is recommended that every charge and discharge be worked within certain limits, dependent upon the cell, unless some abnormal condition arises which calls for excessive discharges from the battery, and under such conditions there should be no hesitancy in calling for the entire battery capacity in the shortest time possible, if required; it is merely the continuous repetition of this excessive work that is to be avoided.

In every case charge should follow discharge in the shortest time possible, as discharged plates in the electrolyte are subject to rapid sulphatation.

If a battery is to be left idle for any length of time some provision should be made for introducing charge as often as once each week. If electrical leakage and local action did not occur, it would of course be possible to let a fully charged battery stand for weeks without any apparent loss, but since these factors are generally present, there must be some provision made for giving the occasional charge; usually an hour's charge at normal rate will suffice.

It might be worth while, if moisture be present in the battery room and where cable connections may easily be removed, to disconnect the separate rows or groups of cells and thus lessen the possibility of leakage.

In case a battery is to be taken out of commission the plates should be fully charged, the acid withdrawn from the cells and replaced by distilled water; the water should be put into the cells as soon as the acid is withdrawn to keep down the heating of the charged negatives. The whole battery should then be discharged. In this case, however, the dis-

charge with the plates in water should be continued until the electromotive force of each cell is practically zero, and this requires a very low external resistance; in fact, near the end of discharge the cells must be short circuited.

After the discharge the water is withdrawn and the plates may be allowed to remain in the tanks until such time as the battery is to be used again, it being only necessary to add the electrolyte and begin charge.

BUCKLING.

Primarily buckled plates are caused by unequal current densities on different portions of the same plate and by excessive formations of sulphate. That there are numbers of causes which contribute to the condition of unequal current densities is evident.

First. This may come about in the manufacture of the plates, where more active material is put on one side of a plate than the other, or the character of the active material may be different on different portions of the plates, or differences in the formation of the plate may give rise to all the conditions necessary to buckle. However, there are comparatively few buckled plates that can be attributed directly to the process of manufacture, and the cause will usually be found elsewhere. Local action may discharge a portion of a plate, forming sulphate in patches or spots, and provided this affected area penetrates the plate to any depth, until it is in an irreducible state, this portion will become worthless, and in addition to doing no work will result in different current densities on the plate tending to distort it. This applies with equal truth to plates that are continually discharged to such an extent that deep and excessive sulphate is formed, and if this sulphate is not uniformly reduced over the entire plate on the following charge there is a tendency for such plate to buckle. More buckled plates probably result from this excessive discharge than from local action, as the formation of sulphate by local action is more or less a self-limiting action, for as soon as the active material in contact with the substance causing local discharge is turned into sulphate, there ceases to be any further action and the affected area is small.

Excessively high rates of discharge can readily cause buckling, due to the fact that the current cannot distribute itself over the plate surface uniformly. This is true of course with normal rates, but in this case there is sufficient metal in the body of the supporting and conducting element to distribute the current fairly well, and the drop between the conducting lug and the furthest portion of the plate is too small, when working within the maximum normal rate, to cause appreciable differences in current density in different portions of the plate.

If, however, plates are subjected to excessive charge or discharge rates the difference of resistance from the conducting lug to different portions of the plate will result in varying current densities over the plate surface and this will cause unequal action.

A buckled plate, however, is not a source of trouble unless it has buckled to such an extent as to come in contact with other plates in the cell. Some plates after they have been in service for a short period take up a position termed their permanent set; that is, they become slightly distorted but seem to keep this set position and apparently no further distortion takes place under normal battery conditions. This is due, evidently, to mechanical strains existing in the plate from its manufacture, and the active service distorts the plate in a direction to relieve the strain.

It appears, however, that this tendency to change from the original straight position would be further augmented with continued action, as the resulting walls of acid on either side of the plate will not be of the same thickness, which changes the resistance, the result being that one side of

the plate will do more than its share of work, since the resistance from that side to the next plate has been reduced. So long, however, as a plate of this kind or one slightly buckled is separated from other plates in the cell no trouble will result, and to all purposes the action of the cell is normal in every way.

When plates have become so distorted as to become troublesome, it is necessary to put them through some straightening process; some plates cannot be straightened; these of course must find their way to the junk pile and new plates substituted. In the straightening process the pressure should be uniform and applied slowly, the use of blows for straightening plates will send them to the junk pile before their time.

If the buckled plates are of small size and each of the plates making up the element is burned to a cross-bar, flat pieces of wood should be inserted between the plates and boards on the outside, the whole being put in a big letter-press or the like and then the pressure slowly applied.

In large cells, in which the plates are burned to a bus-bar, it will be found necessary to cut out the buckled plates and remove them from the cells. Such plates may be straightened by placing them between two smooth, flat-faced surfaces and the pressure applied by pulling the surfaces together with bolts and nuts.

Buckled plates are easily detected when making inspection, and when buckled so far as to come in contact with other plates at once form an internal short circuit.

INTERNAL DISCHARGE.

Local action is due to the presence of foreign metals in the electrolyte, and, as before stated, it is to an extent a self-limiting process on account of the conversion of the active material with which the foreign substance comes in contact, being converted into lead sulphate, that is, this spot of active material in contact is discharged, forming the sulphate and thus stopping further action at this point. However, some substances are carried back and forth in the electrolyte with each successive charge and discharge, the cumulative action in such cases may be serious.

For local action to occur there must exist a difference of potential between the two members forming the local circuit great enough to decompose the electrolyte, and it follows that the local action will be greater or less depending upon the difference of potential between the active material and the substance in contact therewith. This will vary of course with different metals, but it is hardly in the province of this article to tabulate the metals in the order of their activeness when in contact with active materials immersed in dilute sulphuric acid. No foreign substance in a cell can help it, and precautions should be accordingly taken to prevent their occurrence. It may be worth while to note that the positive is subject to practically no troubles from local action; the negative plate, however, is extremely sensitive in this respect.

With the present manufacture of plates and with good quality of brimstone acid no particular troubles from local action should be encountered, provided the cells be kept free from all foreign substances. Internal short circuits may be formed by foreign substances getting into cells and bridging positive and negative plates, or by plates buckling until contact is made with other plates in the cell. Short circuits may also be formed by dislodged active material wedging between plates or by growths on the surface of the active material which may be sufficiently great to joint two plates electrically. The sediment in the bottom of jars or tanks may rise to such a height as to bridge positive and negative plates and thus cause a short circuit. No matter to what source the short circuit is due, the first remedy is to remove the cause, and if it be due to buckled plates the remedy has already been outlined. If the short circuit is caused by lodging of any substance between the plates or by growths from one plate to another, the substance or growth should be removed by means

of a strip of wood or hard rubber. If the short circuit be one of extremely low resistance the passage of current will be excessive, and in some instances has been sufficient to burn away the short circuit path and incidentally those portions of the plate subject to high-current flow.

If the short circuit be one of comparatively high resistance the action on the cell may be very slow and perhaps will not manifest itself for some days. In all cases, however, the effect of short circuits is to discharge the plates and form sulphates. The most prolific cause of short circuits is dislodged active material wedging between the plates. Some of the active material may in time break away from the supporting frame because of excessive expansion and if this material lodge between the plates the short circuit is formed.

Shedding, formation of growths and blistering of active material are due to the combined action of gases evolved on charge as well as to the expansion of the material. If the charge rate be high, the evolved gases are liberated with such rapidity that they urge some of the active material out, and this taken in combination with the weakened structure of the material from continued changes in volume cause it to blister or shed.

As previously pointed out, the disturbance in a cell which takes place on the formation of a short circuit depends on its resistance. If this resistance be high, the cell to all appearances may act normally, but the presence of such a short circuit could readily be detected by the terminal electromotive force of this cell after discharge is continued for some time being lower than the electromotive force of those cells in good condition. In addition, the density of the electrolyte will show that in such cells the acid concentration is lower and cannot be brought up to that of other cells even by protracted charging. Short circuits then manifest themselves, first, by low voltage; second, by low density electrolyte, and the fact that continued charge does not bring the density to the required point, and, further, the presence of sulphate may sometimes be detected by the eye. With the removal of the short circuit the cell is in practically an over-discharged state, and the further remedy lies in prolonged over-charge. This may be done by leaving the cell in circuit and over-charging the battery as a whole in order that sufficient charge may be given to this one cell; this, however, is rather a crude way of effecting the remedy. If the battery is composed of small cells, the connections between them being made by bolting the terminal straps together, a good method is to take the cell requiring the excess charge out of circuit on discharge, bridging across it by means of a jumper, and putting it back in circuit on charge, continuing this operation until the cell has been completely restored.

With large cells in which the plates are burned to a lead bus-bar, it is out of the question to thus cut a cell out and replace it on discharge and charge, and over-charge to this particular cell must be introduced from some other source. Over-charging or boosting a single cell is effected by joining to the cell terminals conductors from some source of current supply independent of the main charging source. In this way it is evident that the boosting can be done at any time, whether the battery is lying idle or is being discharged, and without removing the cell from the circuit. It could also be done while the battery is charging, but this is hardly necessary unless the charging rate to the battery as a whole be very low, for if this boosting of a separate cell be done while the entire battery is charging, the one cell will receive the charging rate of the battery plus the input from the boosting circuit. When a battery is operating on a fluctuating load, charge and discharge taking place in rapid succession, it becomes necessary in case of a diseased cell to cut it entirely out of circuit to administer the proper treatment or else connect the boosting circuit direct to the cell, leaving it in the main battery circuit, and let the charging current to this cell vary from maximum battery charge plus booster input, to maximum battery discharge minus booster

input; if the maximum battery discharge be greater than the boosted input the low cell will be called on for a discharge equal to the difference between the two; however, taken through any length of time the boosted cell will be subject to a continuous net charge. This method is preferable to cutting the cell to receive treatment out of circuit. Cells may be boosted separately from the main circuit with sufficient resistance, generally a water barrel, interposed to limit the charging current to the desired amount. Such a method is extremely wasteful of energy and if it be possible other methods should be used. This boosting may be done from other cells in the battery, by connecting to the bus-bars of the cell to receive charge cables having some form of resistance in circuit to regulate the current, to any pair of cells in the main battery; these two cells forming the source of current supply. As the charge is continued the cables should be shifted to different pairs of cells in order that the energy

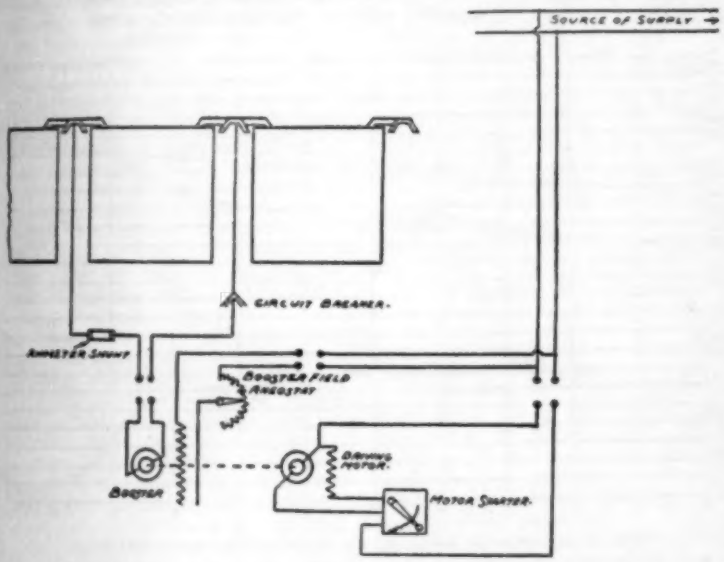


FIG. 2.—DIAGRAM OF CONNECTIONS FOR MOTOR-DRIVEN BOOSTING OUTFIT.

required to restore the diseased cell may be distributed with some uniformity over the entire battery. To carry out such a process it is necessary to take the cell to be charged out of circuit, otherwise a portion of the battery will be short circuited. While such a method is effective and is not very wasteful of energy, it is troublesome to carry out and considerable time is lost in changing the cables to different pairs of cells. In addition to this, it calls for a greater or less discharge from the remaining cells composing the battery. The most satisfactory method is to use a low-voltage generator, specially wound for this purpose.

The best form of such a charging outfit consists of a motor-driven generating set mounted on a small truck that can be moved around in the aisles of the battery room. The motor is wound for the voltage of the system and the capacity of the generator should be the five-hour charge rate of the battery at four or five volts, the field of the generator being separately excited from the system. The rheostat in this generator field should be so designed as to allow the voltage at the brush terminals

to be varied from two to four volts with full armature current. Boosting a single cell with such an outfit is a simple matter and only requires that the proper connections be made between the armature of the generator and the cell bus-bars, the cell remaining in circuit with the others.

In addition to the switches for the motor, generator and generator field, this portable outfit should have a fuse or some protective device in the boosting circuit, a combination over and under-load circuit breaker preferred, and an ammeter.

The connections of the cable to the cell bus-bars may be made by means of special clamps that fit the bus-bars or drilling a hole in each bus and securing the cable lugs by means of bolts.

Fig. 2 shows diagram of connection for a motor-driven boosting outfit as described. In stations operating small batteries the outlay for such boosting apparatus is hardly warranted, but in large installations, where the plates of each cell are burned to lead bus-bars, a motor-driven generating set for boosting separate cells is distinctly worth while. The low

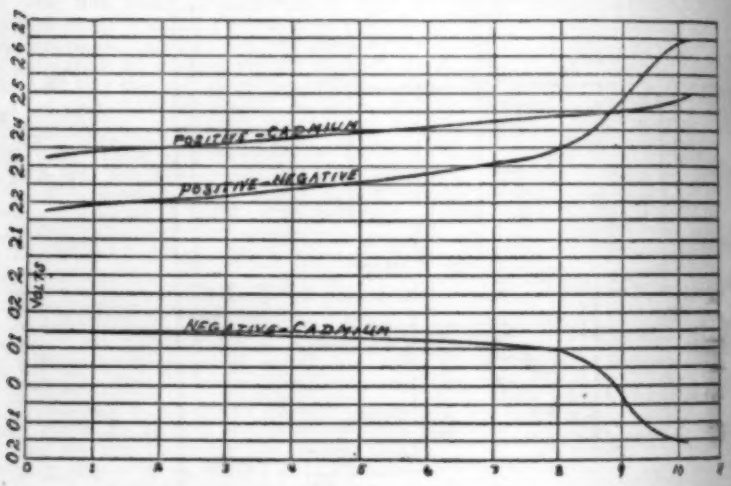


FIG. 3.—CURVES OF VOLTAGE CHANGES IN CADMIUM READINGS.

voltage of the generator makes the size of the booster and motor small, and the expense involved is moderate.

REVERSAL OF CELLS.

If in a battery one or more cells are in a low state of charge as compared with the remainder of the battery, such condition obtaining in the case of a partial short circuit or local action, these cells on discharge will give up their entire capacity in a comparatively short time, and with the continuation of discharge the terminal electromotive force of such cells becomes lower and lower until the zero point is reached, and at this point the discharge current flow from the remainder of the battery is in such a direction as to reverse the low cells.

Since all the cells are connected in series, the current on discharge enters by the negative and leaves by the positive plate, each pair of plates adding its voltage. If the voltage of a cell be reduced to zero and current still continues to flow through it from the remaining cells, the current entering the negative electrode will change the lead sulphate on this plate to lead peroxide, and current leaving *via* the positive plate will convert the sulphate at this point to sponge lead, reversing the cell.

A reversed cell should be given the same treatment as if it were nothing more than a severe case of sulphating. As soon as such a cell is detected it should be cut out of the discharging circuit. A cell in this condition requires prompt attention in order that no serious damage may result.

LOSS OF CAPACITY.

After a battery has been some time in service it will be found that its capacity decreases. This decrease is continuous and does not, in itself, indicate that the battery has been improperly handled, as diminution in capacity is, to a limited extent, one of the natural properties and corresponds to depreciation in other forms of electrical apparatus. This decrease occurs in both plates; the relative rate of decrease, however, is greater in the negative than in the positive, for the reason that there is no formation of new sponge lead by the reactions on this plate during charge and discharge and any loss of active material from any cause will decrease the capacity of the negative proportionately, and these plates lose capacity continuously from the beginning of service to the end of their usefulness. It, however, takes place at a very slow rate.

In the case of the positive plate, new active material is continually being formed from the pure base lead in the body of the plate by the action of the charging current and, to a certain extent, the life of Plante positive plates is dependent upon the amount of pure lead in the structure of the plate that can be converted into lead peroxide.

On account of the more rapid decrease in capacity in the negative than in the positive, it is usual in the manufacture of plates to provide some excess capacity in the negative. It is evident that if new peroxide could be formed with sufficient rapidity to counteract the losses in the positive plate that the capacity of such a plate would remain unchanged until all the available pure lead in the plate had been converted into peroxide. This continued formation of the positive applies only to plates of the Plante type in which the active agent is formed electrochemically directly from the pure lead. In the case of Faure or pasted type positive, there is never any further formation, and a plate of this type is subject to continual losses as with the negative. Another cause of capacity loss is local action, which has already been discussed. While the area attacked by local action may be small in each case, yet if the process be continued for any length of time the result will be more or less clogging of the pores of the active material with small isolated patches of sulphate, decreasing the ability of the electrolyte to circulate freely into the active mass and also reducing the amount of useful active material.

Sulphatation to an excessive degree, either by continual under-charge or over-discharge, will cause growths and studding of the active masses and naturally the capacity decreases as the amount of active material becomes less.

With Plante, or electrochemically formed negatives, it is quite possible when these plates have lost capacity to reform them and prolong their life; this, however, should always be done by the manufacturers. Rejuvenation, or restoring of capacity to a limited extent, can be given to some forms of chloride negatives.

The remedy for loss of capacity, other than that which normally takes place, lies in the form of preventive measures—such as keeping the battery free from all substances which may cause local action and working the battery within its normal limits in order to keep down excessive sulphate and consequent loss of active material by blistering and studding.

VOLTAGE VARIATION.

If at any period of charge or discharge one or more cells show a voltage which is appreciably different from that of the other cells, it may be assumed that such cell or cells are not in proper condition. If the

voltage be in excess of that of the normal cells in the battery, it will be found that the density of the electrolyte has been greatly increased, giving a consequent rise of potential. The remedy is, obviously, to reduce the density of the acid in the cell showing the high voltage. Excessively high acid densities augment the formation of sulphate and greatly increase local action, hence the advisability of preventing the density from becoming too great.

In the case, however, of a sulphated cell the acid density will be lower and the voltage higher than normal cells on the passage of charging current. In nearly every case it will be found that when a cell shows appreciable difference in voltage from other cells its density will be lower, showing over-discharge, loss of capacity, local action or sulphatation, the last being the result of any of the first three causes. At times it may be

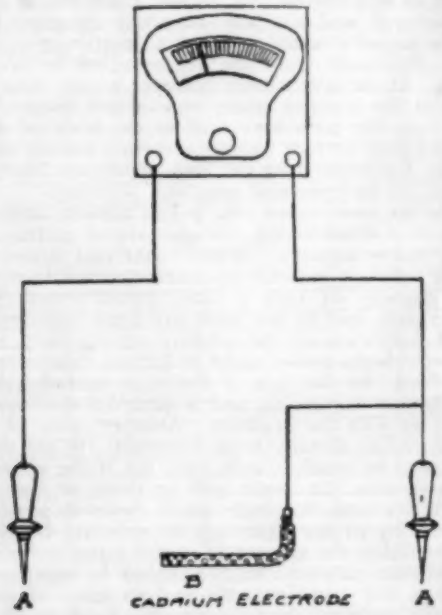


FIG. 4.—VOLTMETER CONNECTIONS FOR TAKING CADMIUM READINGS.

that the effects mentioned have taken place at only one of the electrodes, that is, the positive plate may be in good condition while the negative is not.

Voltmeter readings taken on the positive or negative plates with some neutral metal, such as cadmium, is a good indication of the relative state of charge of the plates under test. Such readings are of special value in the case of the negatives, as this plate is far more sensitive to the effects of local action, loss of active material, etc., than the positive. Since the output of any cell is limited by the capacity of the plates which have the lowest capacity, it is important to know that both are in proper condition before the beginning of discharge. The voltage across the cell terminals is not an indication that both plates are fully charged.

Taking cadmium readings consists of observing the difference of potential between a piece of cadmium immersed in the electrolyte and the

positive or negative electrodes. The difference of potential between the negative electrode and cadmium being small, some error of observation is likely to occur unless this reading is obtained by means of a millivoltmeter, and since such an instrument is rarely available for battery work some other method is generally used to get this potential. The voltmeter usually furnished with a battery installation has a scale ranging from zero to three volts and this instrument must serve for all cell-testing purposes.

A piece of cadmium immersed in the electrolyte of a discharged cell and with normal discharge current flowing will be positive to both the sponge lead and peroxide plates, that is, the voltmeter needle will move in the same direction whether the reading lies between the cadmium and the positive or between the cadmium and the negative, the throw of the needle in the former case being greater than in the latter. Beginning charge at this point, however, the relation of the immersed cadmium to the sponge lead or negative plate changes as the charge proceeds, the change being that while the cadmium is positive to the negative plate at the end of discharge, it becomes negative to this electrode at the end of charge; thus the potential difference between the negative electrode and cadmium begins decreasing with commencement of charge, passes through zero and then becomes negative to the negative electrode with the continuation of the charging current; but from the cadmium to the positive still remains positive. These changes are clearly shown in Fig. 3.

The potential between the cadmium and negative electrode of a cell on discharge will be found to vary from 0.19 to 0.27 volt, depending upon the type and construction of the plates; 0.27 volt being rather too large, 0.20 to 0.25 volt being more nearly good practice for terminal electromotive forces at end of discharge of 1.8 volts per cell.

As charge is continued the potential between the cadmium and the positive electrode increases.

If readings on both positive and negative to cadmium be made, it follows that when readings are in opposite directions the electromotive force of the cell will be given by the addition of the two values, and when the readings are in the same direction the cell electromotive force will be given by their difference. Taking both positive and negative cadmium readings requires manipulation of the voltmeter connections, and there is some liability to error in reading the small deflection from the negative cadmium, so it is usual to take only the cell electromotive force and the potential difference between the positive and the cadmium, the negative reading can be found directly from these two.

Fig. 4 shows the voltmeter connections for taking the readings in this manner. AA are the ordinary prods or stickers connected directly to the voltmeter for taking the voltage in the usual manner and 3 is the cadmium test piece. The method of taking the readings consists of taking the electromotive force by sticking the two prods AA into the terminals of the cell, keeping the cadmium test piece clear of the electrolyte or cell connections; after the electromotive force has been noted remove the prod on the negative terminal and immerse the cadmium test piece, thus getting the potential between it and the positive electrode. From these the negative readings may be computed as previously explained. In taking these readings the cadmium must not come in contact with the plates. A small round bar of cadmium turned up on one end, so that this end will project above the surface of the electrolyte, and the whole covered with a perforated rubber tube, is preferable to a flat sheet of cadmium, as it is possible with the covered bar to lay it across the tops of a number of plates in one cell and so get the average condition of each set of plates, while a flat sheet of cadmium designed to go between a pair of plates gives, to a certain extent, the condition of this particular positive and negative. If such a sheet be used differences will be found to exist in the same cells if the sheet be moved to different pairs of plates.

The potential between the cadmium and the negative at the end of discharge should be from 0.19 to 0.25 volt, and the potential between the positive and the cadmium should be from 1.99 to 2.05 volts. At the end of charge the potential between the positive and the cadmium should be from 2.41 to 2.36 volts, while the corresponding potential at the negative should be from 0.22 to 0.26 volt.

In taking such readings with a cadmium electrode considerable care should be exercised, and it is hardly advisable to take such records oftener than once each month, provided all cells are working normally.

The cadmium test piece should be properly aged by leteting it rest in the electrolyte for a short time before using. It should never be scraped so that a bright surface is exposed, as cadmium will readily oxidize, and there is a difference of potential between cadmium and cadmium oxide that will introduce error in the records.

ELECTROLYTE.

The electrolyte consists of dilute sulphuric acid, and the acid used should be in every case the so-called brimstone acid, as that manufactured from sulphide of iron contains arsenic, iron and other harmful impurities.

The density of the mixture of distilled water and brimstone acid when first put into the cells generally varies from 1.210 to 1.225 and in motor-car work the density is even greater, usually 1.235 to 1.255.

Lower densities, however, are to be recommended, as sulphatation is accelerated with high-density electrolyte and the deterioration is more rapid. This lowering of the electrolyte density would decrease the working voltage per cell, but the cost of a few additional cells to make up the total voltage required, if low-density electrolyte be used, would be more than compensated for if the life of the entire battery be prolonged.

When a cell is fully charged the density of the electrolyte is a maximum, and as discharge proceeds this density decreases continually, due to the formation of lead sulphate by combining of the lead oxides of the plates and SO_3 taken from the electrolyte. It also follows that on charge the density will continue to increase so long as the reduction of lead sulphate back to sponge lead and lead peroxide continues, and the electrolyte density will therefore vary between charge and discharge. This variation is dependent upon the amount of electrolyte in each cell, and while high densities are to be avoided, it is also necessary that the density at the end of discharge should not fall too low. This requires that if lower initial densities be used, a greater amount of electrolyte is required in order that the terminal densities may not be too greatly lowered.

It is common practice in this country to allow from fourteen to eighteen pounds of electrolyte per 100 ampere-hours. On the basis of fifteen pounds per 100 ampere-hours, with an initial density of 1.210, the variation in density would be from 1.210 to 1.175 approximately for a full discharge.

Acid density readings should be taken once each week in every cell, and as far as possible at the time when the battery is in the same state of charge or discharge, in order that different sets of records may be used for comparison. If the battery is composed of a large number of cells it is hardly advisable to insist on readings being taken at more frequent intervals, as it is likely in such a case that the records might be filled out without the hydrometer having actually been used. Specific gravity readings, when carefully taken, form an excellent basis on which to study battery performance, as the density of the electrolyte is a reliable indication of the state of charge or discharge, provided the cells are perfectly normal; and any trouble will manifest itself by a change in density from the normal charge and discharge variation. When a battery is first put in commission, the acid should be carefully watched as differences in the plates in various cells will cause changes in density in the battery as a

whole, and the changes from charge to discharge and *vice versa* will not be uniform.

In giving the initial charge and for several succeeding charges, the current should be continued until the acid density in each cell stops rising. At this point the density from cell to cell will be found to vary considerably, and to make all cells uniform some of the electrolyte should be drawn from those cells in which the gravity is too high and replaced by distilled water. If in cells which show too low a density, the specific gravity cannot be increased after several charges, it is then advisable to add small quantities of dilute acid, about 1.400, to bring the electrolyte to the proper density.

This addition of acid should not be made until such cells have been thoroughly examined and it is definitely ascertained that this low density is not caused by short circuits, local action or the like.

After the electrolyte has been equalized over the entire battery there should be no further addition to the acid. It is essential that the plates at all times be completely submerged, and to take up any loss in solution by evaporation or spraying distilled water only should be added. Very little acid is lost by spraying and the amount that goes into permanent combination with the active materials is small, so that there is no danger to be feared from weakened electrolyte.

The more important times to take gravity readings are just after full charge and after discharge. If the discharge rate has been excessive the gravity readings should not be taken immediately. A short time should be allowed in order that free circulation may take place.

When a cell is subjected to high rates of discharge, those portions of the electrolyte that may be in intimate contact with the active masses will rapidly decrease in density, due to the fact that the SO_3 is extracted from these portions, going into the combination with the sponge lead and the peroxide of lead to form lead sulphate; this rapid formation of sulphate decreases the ability of the electrolyte to circulate freely in the pores of the active masses and the cell electromotive force drops accordingly. For this reason time must be allowed for proper circulation before taking specific gravity readings after a high discharge. This applies with equal force to excessive charge rates as far as allowing time for circulation is concerned.

If the containing tanks of a cell be very deep there will be a difference in acid concentration between the top and bottom layers; this may give rise to more rapid action on the bottom of the plates than on the top and thus result in buckled plates. In tanks of this nature the work and wear on the plates are not distributed uniformly, as shown, by the fact that in very long plates the bottoms deteriorate much more rapidly than the tops, in fact some instances show the tops of the plates to be in good condition while the bottoms are worthless.

When tanks are very deep it may be necessary to keep the electrolyte in circulation by some artificial means such as an air blast, the air being introduced at the bottom of the tanks by means of rubber hose.

CLEANING AND REMOVAL OF SEDIMENT.

With the continued action of a battery there is a steady accumulation of sediment on the bottom of the containing tanks or jars. This sediment is, of course, harmless so long as it does not touch the plates, but when its height is sufficiently great to bring it in contact with the plates, it immediately becomes a source of trouble and must be removed.

The method employed for removing sediment will depend upon the type of cell and somewhat on local conditions.

In the manufacture of tanks and jars for battery work, considerable space is allowed between the bottom edges of the plates and the bottom of the tanks and all this space is available for the accumulation of sediment, and usually it will be found that by the time this space has been

completely filled that quite a large number of plates are worn out, so that in such cases the process of renewing the plates and cleaning the tanks can be done simultaneously.

If the battery is made up of small cells in glass containing jars, connections being made by bolting the terminal straps, it is comparatively a simple matter to remove the element and then dump the sediment. This work can be done by dismantling the whole battery, taking it out of service for a week or more, or one cell at a time may be attended to without interrupting the service from the battery as a whole.

If the elements be installed in lead-lined tanks with bus-bar connections, the matter of sediment removal is more difficult, and, under certain conditions, nothing short of dismantling the battery and dumping the sediment directly from the tanks will suffice.

If the tank capacity is greater than that of the installed element, leaving a space between one side of the tank and the element, it may be possible to remove the greater portion of the sediment by means of a scoop thrust down through the existing space; while all the sediment cannot be got out, a sufficient quantity may be removed to obviate the possibility of a short circuit.

This method has the disadvantage of producing a very dirty electrolyte, but this may be compensated for by the fact that the service is not discontinued.

If the tanks be completely filled with plates it is necessary to dismantle the cell if the work be done effectively.

Batteries have been "flushed" out with indifferent success by a stream of water under high pressure; where the tanks are not too deep and if the sediment is not packed in this process will sometimes relieve the trouble. Flushing out tanks requires that the battery room be laid out to take care of a large amount of water that will be scattered around, and the resulting leakage from moisture will probably give rise to other troubles equally as interesting as short circuits from sediment. To carry out such a method of cleaning requires a large quantity of water and patience out of proportion to the results obtained.

One ingenious method for removing the plates from a cell without cutting the bus-bar connections consists in lifting out of two adjacent tanks the plates connected to the bus-bar between them until the tank is cleaned; in this manner the plates in all the cells excepting those on the end of a row may be removed without cutting any of the bus connections.

Another method consists in arranging the cells when they are installed so that the liquid may be drawn off, by burning a lead-pipe connection in the bottom of each tank, the outer end of this pipe being, of course, sealed. Tanks embodying this feature of construction can be readily relieved of accumulated sediment by cutting the seal on the outer end of the pipe, a new seal being burned on before acid is again poured into the tank.

RECORDS.

It is safe to assume that the majority of battery troubles are due directly to continued over-discharge or, what amounts to the same thing, so far as occasioning trouble is concerned, under-charging. Of the two under-charging is probably the more prolific cause of trouble.

The last part of the charge being just as important as the first, it is essential that the current be continued until the battery exhibits every sign of full charge, regardless of the fact that the ampere-hours of charge, up to a certain point, may exceed the previous discharge by an amount sufficient to compensate for the losses in the battery. The several indications of full charge are: terminal voltage (which should be from 2.4 to 2.63 volts per cell, depending upon the rate of charge), density of the electrolyte, color of plates and gassing of both positive and negative plates. To insure best results and as a preventive measure against trouble, it is

imperative to keep a set of records of the battery as a whole and on each individual cell. Such records constitute a history, so to speak, of all battery operations, and in case of trouble developing they should form the basis for deciding the proper methods to be pursued to restore normal conditions. The kinds of records kept and the time given to taking them depend largely on the class of installation, it being evident that batteries operating in small stations with limited attendance cannot get the same care as in larger stations where there may be one or more attendants whose entire time is devoted to the battery.

There are, however, certain records that are necessary and common to all classes of stationary batteries.

In order that such records be of any value it is necessary that they be carefully made and with some regularity. Carefully taken records at intervals of from one to two weeks are infinitely more valuable than those at much shorter intervals if the work be hurriedly and carelessly done. Since records are to be used comparatively and, further, as this comparison should be extended to individual cells as well as to the entire battery, it is necessary that separate cell records be made. The practice of obtaining data from only one cell, so-called "pilot cell," is not to be recommended, and it is absurd to suppose that the performance of any one cell of a battery made up of, say, 255 such cells can furnish any idea as to actual conditions throughout the battery.

This method to an extent defeats the object of taking individual cell records, which is to ascertain if local trouble exists.

The pilot cell is a makeshift at best, and furnishes an excellent excuse if any difficulty develops in any other part of the battery. Usually the pilot cell never behaves in any but the most exemplary manner, thanks to judicious doctoring.

It has been pointed out that specific gravity readings of the electrolyte should generally be taken at two periods; namely, at or near the end of discharge and of charge. Specific gravity for some purposes gives a far more accurate idea as to the condition of cells than voltage, although both should be considered jointly. For instance, a sulphated cell may indicate 2.5 volts on the passage of the charging current and consideration of the voltage only would indicate full charge. The low acid concentration in this cell will, however, show the error.

In order that the data may be complete the voltage and acid readings should be taken at the same time, or one set of readings should follow the other in the shortest time possible, and the order for taking these readings is to observe the voltage first when the battery is nearing the end of the charge or discharge and the gravity readings taken as soon thereafter as possible.

In observing the voltage the battery should always be under load, that is to say, current should be either passing to or from the cells. It has been previously shown that in case the rate of charge or discharge is excessive, time should be allowed for calculation of the electrolyte before observing the specific gravity. The usual variation in the density of the electrolyte between charge and discharge is from 1.210 to 1.180, and cells working normally should all read from two to fifteen points of each other, it being practically impossible to make the acid in all cells exactly the same density; but marked differences should be noted and the cause corrected.

Cell voltages should be taken and recorded with the same frequency and regularity as the specific gravity. It is, however, advisable to go over the battery much oftener with a voltmeter even if these readings are not recorded. As a matter of fact, successful operation requires that it be done every day, as this is a quick way of ascertaining if any other than normal conditions prevail; as it is to differences in individual cells from those in the remainder of the battery that we have to depend for finding local trouble.

A battery record sheet should include gravity readings of every cell, voltages on all cells and remarks as to the color of the plates, whether any plates are buckled or dished; also the temperature of the battery room and the cells, and, further, the rate of charge or discharge, when such readings were taken, should be noted. This record sheet should be provided with a space for general remarks, when in troubles of any kind, and manner of carng for same should be noted.

It is hardly necessary in the general run of stations to take regular cadmium readings over every cell and record these in detail. It is essential, however, that such readings be made and recorded, but as a general thing five or six such sets of readings per year will suffice, and it is hardly worth while to provide for this on the regular record sheets, as these readings may be tabulated separately, and where cadmium readings are made on a few cells the data may be noted under the heading of general remarks.

Such a set of records relate directly to the cells and should be accompanied with further data that can be obtained at the switchboard. There are certain switchboard records that can be obtained every day without much trouble, and are quite as important as cell readings.

If the battery be on a lighting service where it is called on to discharge on a peak or to carry the entire load for a time, the rational method of keeping track of charge and discharge is to include a load curve in the records; this load curve from the battery showing charge and discharge may be incorporated in one of the regular station load diagrams. At any rate, such a curve should appear in the station diagram or else be included in the records relating to the battery. This curve is plotted from readings on the battery ammeter taken at suitable intervals; the frequency with which they should be taken will of course depend upon the rate at which the battery input or output is changing, being more frequent as the load changes most rapidly.

Such a curve is of value in that it shows not only the ratio of input to output, but it indicates the different rates at which charge and discharge took place. If the battery be operating on a three-wire system, a curve for each side of the system is required. In the case of batteries operating on railway circuits or the like, where charge and discharge follow each other in rapid succession, the method of finding the gross input and output per day is not such a simple matter.

An ammeter in the battery circuit will indicate maximum charges and discharges, but accurate records from an ammeter needle that is continually moving and sometimes at a rapid rate are difficult to obtain, and readings taken at, say, fifteen-minute intervals are useless and represent a certain waste of time.

The input and output in such a case may be obtained with sufficient accuracy by means of two wattmeters in the battery circuit, a polarized relay being used to connect the pressure coils of the charge and discharge meters in circuit as the current in the battery circuit changes from charge to discharge or *vice versa*.

A recording ammeter, plotting both charge and discharge on a straight scale, would be better, for, in addition to showing the gross input and output, it would indicate the rates at which the charges and discharges took place. The scale for such an instrument would, of course, have a zero line, charge being plotted on one side and discharge on the other. The sum of the integrated areas on one side would be the total ampere-hour output and the sum of the areas on the other side of the zero line would be the total ampere-hour input for a time corresponding to the length of the ammeter record.

These quantities, the total input and total output, are just as important in the case of batteries working on fluctuating load as on lighting batteries, as any change in the relation of these two quantities will result in a change in the state of battery charge and their magnitude will affect the question of life.

While a battery working on a fluctuating load may never charge or discharge above its normal one-hour rating, the ampere-hour output may in the course of a day exceed several times the ampere-hour capacity of the battery on straight discharge work, or, in other words, the work done per day on fluctuating loads may be several times that of the actual capacity of the battery through one complete discharge.

This daily total ampere-hour output is aptly termed by W. W. Donaldson the "diurnal activity" of a battery, the basis of comparison being the ampere-hour capacity of a battery at the one-hour rate of discharge, so that a battery discharging in one day three times its capacity at the one-hour rate would have a diurnal activity of three.

The greater this factor the greater will be the net work done by the battery, and as the diurnal activity increases the life decreases.

It cannot be assumed, however, that a battery having an activity, say, of three, would be subject to the same deterioration that would obtain if this battery were operating on three complete cycles of charge and discharge per day, where each discharge lasts for one hour and is continuous from beginning to end of discharge.

In working on fluctuating loads in which the time interval of discharge is comparatively short, the formation of lead sulphate on both electrodes for the production of this output is small, thus limiting the change in volume of both plates, and as charge follows discharge immediately, the small amount of sulphate is at once converted, so that the plates are never subject to discharges requiring the formation of deep sulphate and corresponding changes in volumes of the electrodes, as is the case where the discharge is a continuing process, until the entire capacity has been given up; and then life would consequently be longer than that of a battery working on continuous discharges.

LIST OF PRIZE ESSAYS.

1879.

Naval Education. Prize Essay, 1879. By Lieut-Com. A. D. Brown, U.S.N.

NAVAL EDUCATION. First Honorable Mention. By Lieut.-Com. C. F. Goodrich, U.S.N.

NAVAL EDUCATION. Second Honorable Mention. By Commander A. T. Mahan, U.S.N.

1880.

"The Naval Policy of the United States." Prize Essay, 1880. By Lieutenant Charles Belknap. U.S.N.

1881.

The Type of (I) Armored Vessel, (II) Cruiser best suited to the Present Needs of the United States. Prize Essay, 1881. By Lieutenant E. W. Very, U.S.N.

SECOND PRIZE ESSAY, 1881. By Lieutenant Seaton Schroeder, U.S.N.

1882.

Our Merchant Marine: The Causes of its Decline and the Means to be taken for its Revival. "Nil clarius aquis." Prize Essay, 1882. By Lieutenant J. D. J. Kelley, U.S.N.

"MAIS IL FAUT CULTIVER NOTRE JARDIN." Honorable Mention. By Master C. G. Calkins, U.S.N.

"SPERO MELIORA." Honorable Mention. By Lieut.-Com. F. F. Chadwick, U.S.N.

"CAUSA LATET: VIS EST NOTISSIMA." Honorable Mention. By Lieutenant R. Wainwright, U.S.N.

1883.

How may the Sphere of Usefulness of Naval Officers be extended in Time of Peace with Advantage to the Country and the Naval Service? "Pour encourager les Autres." Prize Essay, 1883. By Lieutenant Carlos G. Calkins, U.S.N.

"SEMPER PARATUS." First Honorable Mention. By Commander N. H. Farquhar, U.S.N.

"CUILIBET IN ARTE SUA CREDENDUM EST." Second Honorable Mention. By Captain A. P. Cooke, U.S.N.

1884.

The Reconstruction and Increase of the Navy. Prize Essay, 1884. By Ensign W. I. Chambers, U.S.N.

1885.

Inducements for Retaining Trained Seamen in the Navy, and Best System of Rewards for Long and Faithful Service. Prize Essay, 1885. By Commander N. H. Farquhar, U.S.N.

1886.

What Changes in Organization and Drill are Necessary to Sail and Fight Effectively Our Warships of Latest Type? "Scire quod nescias." Prize Essay, 1886. By Lieutenant Carlos G. Calkins, U.S.N.

THE RESULT OF ALL NAVAL ADMINISTRATION AND EFFORT FINDS ITS EXPRESSION IN GOOD ORGANIZATION AND THOROUGH DRILL ON BOARD OF SUITABLE SHIPS. Honorable Mention. By Ensign W. L. Rodgers, U.S.N.

1887.

The Naval Brigade: its Organization, Equipment and Tactics. "In hoc signo vinces." Prize Essay, 1887 By Lieutenant C. T. Hutchins, U.S.N.

1888.

Torpedoes. Prize Essay, 1888. By Lieut.-Com. W. W. Reisinger, U.S.N.

1891.

The Enlistment, Training and Organization of Crews for our Ships of War. Prize Essay, 1891. By Ensign A. P. Niblack, U.S.N.

DISPOSITION AND EMPLOYMENT OF THE FLEET: SHIP AND SQUADRON DRILL. Honorable Mention, 1891. By Lieutenant R. C. Smith, U.S.N.

1892.

Torpedo-boats: their Organization and Conduct. Prize Essay, 1892. By Wm. Laird Clowes.

1894.

The U.S.S. Vesuvius, with Special Reference to her Pneumatic Battery. Prize Essay, 1894. By Lieut.-Com. Seaton Schroeder, U.S.N.

NAVAL REFORM. Honorable Mention, 1894. By Passed Assistant Engineer F. M. Bennett, U.S.N.

1895.

Tactical Problems in Naval Warfare. Prize Essay, 1895. By Lieut.-Com. Richard Wainwright, U.S.N.

A SUMMARY OF THE SITUATION AND OUTLOOK IN EUROPE. An Introduction to the Study of Coming War. Honorable Mention, 1895. By Richmond Pearson Hobson, Assistant Naval Constructor, U.S.N.

SUGGESTIONS FOR INCREASING THE EFFICIENCY OF OUR NEW SHIPS. Honorable Mention, 1895. By Naval Constructor Wm. J. Baxter, U.S.N.

THE BATTLE OF THE YALU. Honorable Mention, 1895. By Ensign Frank Marble, U.S.N.

1896.

The Tactics of Ships in the Line of Battle. Prize Essay, 1896. By Lieutenant A. P. Niblack, U.S.N.

THE ORGANIZATION, TRAINING AND DISCIPLINE OF THE NAVY PERSONNEL AS VIEWED FROM THE SHIP. Honorable Mention, 1896. By Lieutenant Wm. F. Fullam, U.S.N.

NAVAL APPRENTICES, INDUCEMENTS, ENLISTING AND TRAINING. The Seaman Branch of the Navy. Honorable Mention, 1896. By Ensign Ryland D. Tisdale, U.S.N.

THE COMPOSITION OF THE FLEET. Honorable Mention, 1896. By Lieutenant John M. Ellicott, U.S.N.

1897.

Torpedo-boat Policy. Prize Essay, 1897. By Lieutenant R. C. Smith, U.S.N.

A PROPOSED UNIFORM COURSE OF INSTRUCTION FOR THE NAVAL MILITIA. Honorable Mention, 1897. By H. G. Dohrman, Associate Member, U.S.N.I.

TORPEDOES IN EXERCISE AND BATTLE. Honorable Mention, 1897. By Lieutenant J. M. Ellicott, U.S.N.

1898.

Esprit de Corps: A Tract for the Times. Prize Essay, 1898. By Captain Caspar Frederick Goodrich, U.S.N.

OUR NAVAL POWER. Honorable Mention, 1898. By Lieut.-Com. Richard Wainwright, U.S.N.

TARGET PRACTICE AND THE TRAINING OF GUN CAPTAINS. Honorable Mention, 1898. By Ensign R. H. Jackson, U.S.N.

1900.

Torpedo Craft: Types and Employment. Prize Essay, 1900. By Lieutenant R. H. Jackson, U.S.N.

THE AUTOMOBILE TORPEDO AND ITS USES. Honorable Mention, 1900. By Lieutenant L. H. Chandler, U.S.N.

1901.

Naval Administration and Organization. Prize Essay, 1901. By Lieutenant John Hood, U.S.N.

1903.

Gunnery in Our Navy. The Causes of its Inferiority and Their Remedies. Prize Essay, 1903. By Professor Philip R. Alger, U.S.N.

A NAVAL TRAINING POLICY AND SYSTEM. Honorable Mention, 1903. By Lieutenant James H. Reid, U.S.N.

SYSTEMATIC TRAINING OF THE ENLISTED PERSONNEL OF THE NAVY. Honorable Mention, 1903. By Lieutenant C. L. Hussey, U.S.N.

OUR TORPEDO-BOAT FLOTILLA. The Training Needed to Insure its Efficiency. Honorable Mention, 1903. By Lieutenant E. L. Beach, U.S.N.

1904.

The Fleet and its Personnel. Prize Essay, 1904. By Lieutenant S. P. Fullinwider, U. S. N.

A PLEA FOR A HIGHER PHYSICAL, MORAL, AND INTELLECTUAL STANDARD OF THE PERSONNEL FOR THE NAVY. Honorable Mention, 1904. By Medical Inspector Howard E. Ames, U. S. N.

NOTICE.

The U. S. Naval Institute was established in 1873. having for its object the advancement of professional and scientific knowledge in the Navy. It now enters upon its twenty-eighth year of existence, trusting as heretofore for its support to the officers and friends of the Navy. The members of the Board of Control cordially invite the co-operation and aid of their brother officers and others interested in the Navy, in furtherance of the aims of the Institute, by the contribution of papers and communications upon subjects of interest to the naval profession, as well as by personal support and influence.

On the subject of membership the Constitution reads as follows:

ARTICLE VII.

Sec. 1. The Institute shall consist of regular, life, honorary and associate members.

Sec. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members, without ballot, on payment of dues or fee to the Secretary and Treasurer, or to the Corresponding Secretary of a Branch. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

Sec. 3. The Prize Essayist of each year shall be a life member without payment of fee.

Sec. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control, and a vote equal to one-half the number of regular and life members, given by proxy or presence, shall be cast, a majority electing.

Sec. 5. Associate members shall be elected from officers of the Army Revenue Marine, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

Sec. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

Sec. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: "Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control, and, if their report be favorable, the Secretary and Treasurer shall make known the result at the next meeting of the Institute, and a vote shall then be taken, a majority of votes cast by members present electing.

The Proceedings are published quarterly, and may be obtained by non-members upon application to the Secretary and Treasurer at Annapolis, Md. Inventors of articles connected with the naval profession will be afforded an opportunity of exhibiting and explaining their inventions. A description of such inventions as may be deemed by the Board of Control of use to the service will be published in the Proceedings.

Single copies of the Proceedings, $1.00. Back numbers and complete sets can be obtained by applying to the Secretary and Treasurer, Annapolis, Md.

Annual subscriptions for non-members, $3.50. Annual dues for members and associate members, $3.00. Life members fee, $30.00.

All letters should be addressed to Secretary and Treasurer, U. S. Naval Institute, Annapolis, Md., and all checks, drafts and money orders should be made payable to his order, without using the name of that officer.

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SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1904.

A prize of two hundred dollars, with a gold medal, and a life-membership in the Institute, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1904. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. If, in the opinion of the Board of Control, the best essay presented is not of sufficient merit to be awarded the prize, it may receive "Honorable Mention" or such other distinction as the Board may decide.

5. In case one or more essays receive "Honorable Mention," the writer of the first of them in order of merit will receive seventy-five dollars and a life-membership in the Institute.

6. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

7. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

8. All essays submitted must be either typewritten or copied in a clear and legible hand.

9. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of the gold medal.

By direction of the Board of Control.

PHILIP R. ALGER,
Professor, U. S. N., Secretary and Treasurer.